

DISTRIBUTION AND BIOLOGY OF MYSIDS (CRUSTACEA, MYSIDACEA) FROM THE ATLANTIC COAST OF THE UNITED STATES IN THE NMFS WOODS HOLE COLLECTION

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ABSTRACT

Nineteen species of marine mysids, representing 16 genera, have been assembled at the NMFS Biological Laboratory, Woods Hole, Mass. These specimens were collected between 1953 and 1969 from the continental shelf and slope off the east coast of the United States between Canada and southern Florida. The species represented are: *Eucopia grimaldii*, *Boreomysis tridens*, *Bowmaniella portoricensis*, *Anchialina typica*, *Erythrops erythrophthalma*, *Meterythrops robusta*, *Hypererythrops caribbaea*, *Pseudomma affine*, *Pseudomma* sp., *Amblyops abbreviata*, *Bathymysis renoculata*, *Mysidopsis bigelowi*, *M. furca*, *Promysis atlantica*, *Mysis mixta*, *M. stenolepis*, *Praunus flexuosus*, *Neomysis americana*, and *Heteromysis formosa*.

Geographic and bathymetric distributions, relations with bottom sediments, and other ecological information are given for all species. Biological data such as spawning season, clutch size, body length at maturity, and similar information are reported for 11 species. More detailed accounts of the life history and ecology of *Erythrops erythrophthalma*, *Mysidopsis bigelowi*, and *Neomysis americana* are made possible by the large numbers of specimens of these species.

This report is based on the collection of mysids assembled by the Food Habits Project and the Benthic Invertebrates Project at the National Marine Fisheries Service (NMFS), Biological Laboratory—formerly known as the Bureau of Commercial Fisheries (BCF)—Biological Laboratory, Woods Hole, Mass. Mysids were not specifically sought in assembling this collection; they were acquired from biological samples collected for ecological studies pertaining to various kinds of demersal fishes and assemblages of benthic invertebrates. Estuarine and inshore species are few because nearly all sampling was conducted in offshore areas.

The known mysidacean fauna off the eastern coast of the United States is not extensive. Tattersall (1951) made a thorough review of the literature and the mysid specimens in the U.S. National Museum. He reported only 11 shallowwater (less than 200 m) species occur-

ring in the area between Maine and Florida. This includes estuarine and shore forms as well as middle and outer continental shelf species. Although a few additional species have been found in this area since the time of Tattersall's study (Klawe, 1955; Bowman, 1957, 1964; Wigley, 1963; Băcescu, 1963; Haefner, 1968; and others) and undoubtedly some species remain undetected, it is reasonable to conclude that only a modest number of different kinds of mysids occur in this region.

A substantial portion of the species in the NMFS samples from the western Atlantic also occur in European waters. They are: *Eucopia grimaldii*, *Boreomysis tridens*, *Erythrops erythrophthalma*, *Meterythrops robusta*, *Pseudomma affine*, *Amblyops abbreviata*, *Mysis mixta*, *Praunus flexuosus*, and *Heteromysis formosa*. Those species that do not have an ampho-Atlantic distribution are largely indigenous to the western North Atlantic, namely: *Bowmaniella portoricensis*, *Hypererythrops caribbaea*, *Pseudomma* sp., *Bathymysis renoculata*, *Mysidopsis bigelowi*, *M. furca*, *Mysis stenolepis*, and *Neomysis*

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americana. These indigenous species are all inhabitants of warm-temperate to tropical areas; none are subarctic or boreal. Presumably members of this group have been unable to bridge the ocean because of unfavorable water temperatures across the northern rim of the Atlantic Ocean where water depths are favorable. *Amblyops abbreviata* and *Meterythrops robusta*, in addition to having an amphi-Atlantic distribution, are also widely distributed in the North Pacific Ocean. Only *Anchialina typica*, which occurs in the Atlantic and Pacific Oceans, and *Promysis atlantica*, which occurs in the North and South Atlantic Oceans, do not fall into the two main categories above.

The European species *Praunus flexuosus*, now well established in the coastal waters of New England, may have been introduced rather recently by the activities of man (discussion on pages 735 and 736).

The information presented herein supplements our scanty knowledge of the biology of individual species and also provides a general review of the kinds of mysids in the western Atlantic, their distribution, relative abundance, and relations with some environmental characteristics.

MATERIALS AND METHODS

Three million specimens representing 19 species and 16 genera were collected during 1953-69 from the continental shelf and slope off the eastern coast of the United States between Canada and southern Florida.

Two-thirds of the samples were collected from the offshore New England region, between Nova Scotia, Canada, and Long Island, N.Y. (Figure 1). About 2,000 samples were analyzed from this region. Sparse sampling (1,000 samples) was conducted between New York and Key West, Fla. Most of the collections were taken by six oceanographic research vessels: *Albatross III*, *Albatross IV*, *Blueback*, and *Delaware*, all operated by the National Marine Fisheries Service; and *Asterias* and *Gosnold*, operated by the Woods Hole Oceanographic Institution, Woods Hole, Mass. Collection data and biological information for each sample of mysids in

the NMFS collection are given in Burns and Wigley.² The collection data include: latitude and longitude, water depth, date, sampling gear, vessel name, cruise and station number. The biological information consists of the number of specimens, summary of body length by species, sex, and stage of maturity.

The 12 kinds of sampling instruments used in collecting mysids were: bottom skimmer, Campbell grab, dip net, 30-cm ring net, 1-m ring net, plankton net, naturalists dredge, otter trawl, sled-mounted ring net, Smith-McIntyre grab, shrimp trawl, and Van Veen grab. A few specimens were obtained from fish stomachs. The kinds of gear most successful in catching mysids were ring nets, grab samplers, the bottom skimmer (a combination dredge and plankton net), and dredges with fine-mesh nets. Only occasional specimens were obtained with bottom trawls and dredges with coarse mesh nets.

Mysids were preserved in Formalin at sea and transferred to ethyl alcohol at the time the samples were sorted in the laboratory ashore.

In classifying larvae according to their stage of development, we have followed Nair (1939).

A total of 5,566 specimens were examined under low-power magnification with a binocular microscope to determine sex and stage of maturity and to measure size. Body length was measured from the anterior margin of the carapace to the posterior end of the telson, using an ocular micrometer in the microscope.

SYSTEMATIC ARRANGEMENT

For the systematic arrangement and terminology we have followed Tattersall and Tattersall (1951). The list of species in their respective groupings are as follows:

² Burns, Bruce R., and Roland L. Wigley. 1970. Collection and biological data pertaining to mysids in the collection at the BCF Biological Laboratory, Woods Hole. Lab. Ref. No. 70-2, 36 p. Bur. Commer. Fish. Biol. Lab., Woods Hole, Mass. (Unpublished manuscript.)

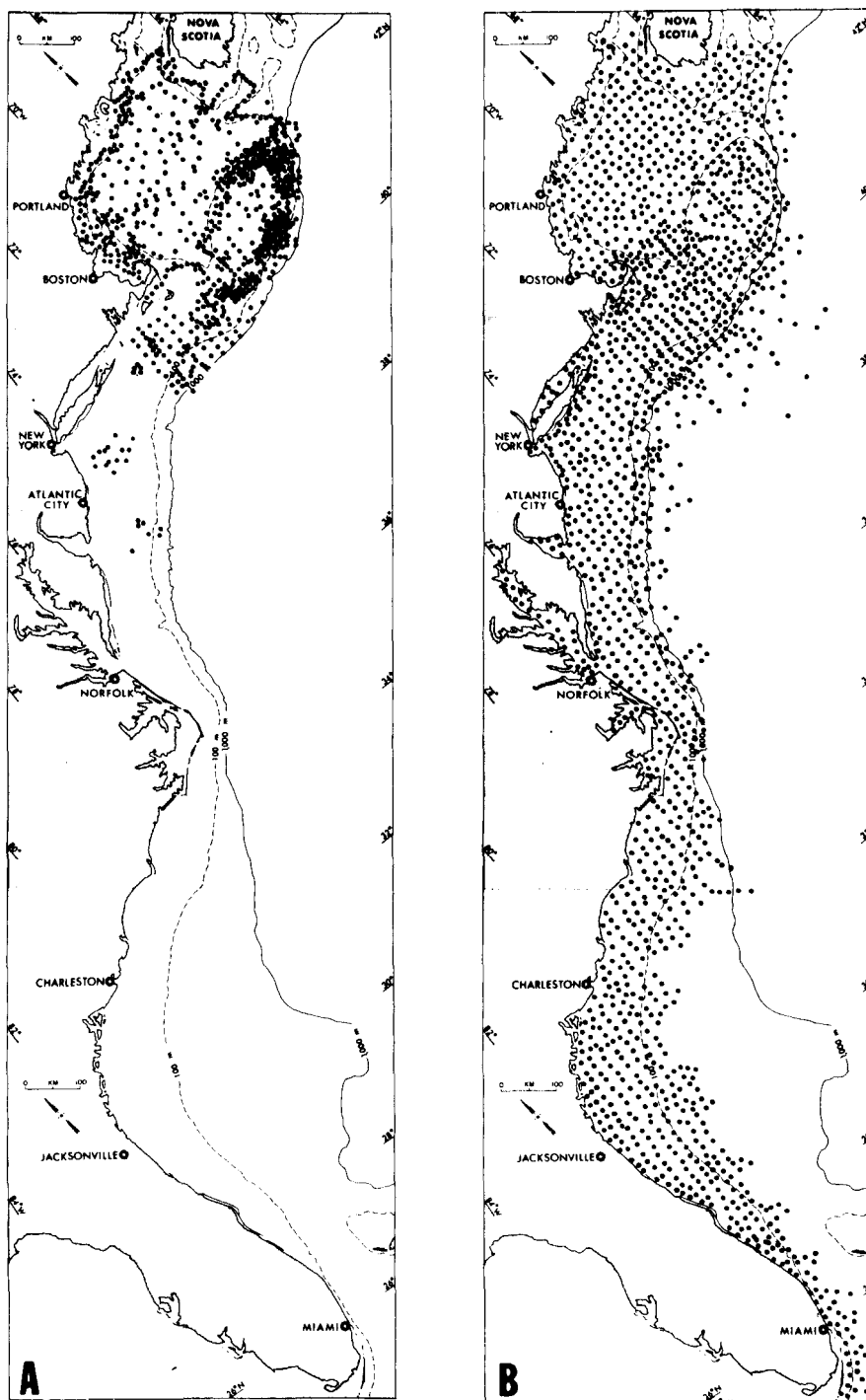


FIGURE 1.—Chart of the Atlantic Continental Shelf and adjacent area showing the location of sampling stations. A. Samples collected with dredges and similar types of collection instruments. B. Samples collected by means of grab samplers.

Order MYSIDACEA

Suborder LOPHOGASTRIDA

Family EUCOPIIDAE

Eucopia grimaldii Nouvel, 1942

Suborder MYSIDA

Family MYSIDAE

Subfamily BOREOMYSINAE

Boreomysis tridens G. O. Sars,
1870

Subfamily GASTROSACCINAE

Bowmaniella portoricensis
Băcescu, 1968
Anchialina typica (Krøyer, 1861)

Subfamily MYSINAE

Tribe ERYTHROPINI

Erythroops erythrophthalma
(Goës, 1864)
Meterythroops robusta S. I. Smith,
1879
Hypererythroops caribbaea Tattersall, 1937
Pseudomma affine G. O. Sars,
1870
Pseudomma sp.
Amblyops abbreviata (M. Sars,
1869)

Tribe LEPTOMYSINI

Bathymysis renoculata Tattersall,
1951
Mysidopsis bigelowi Tattersall,
1926
Mysidopsis furca Bowman, 1957
Promysis atlantica Tattersall,
1923

Tribe MYSINI

Mysis mixta Lilljeborg, 1852
Mysis stenolepis S. I. Smith, 1873
Praunus flexuosus (O. F. Müller,
1776)
Neomysis americana (S. I. Smith,
1873)

Tribe HETEROMYSINI

Heteromysis formosa S. I. Smith,
1873

SPECIES ACCOUNTS

Order MYSIDACEA

Suborder LOPHOGASTRIDA

Family EUCOPIIDAE

Eucopia grimaldii Nouvel, 1942

This mysid is a moderately large bathypelagic species that occurs most commonly at depths of about 2,000 m and has not been found at less than 300 m. Its geographic distribution is cosmopolitan, it having been reported from the North and South Atlantic, Pacific, and Indian Oceans. The majority of records are from temperate and tropical waters, but it has been recorded from as far north as Iceland and southern Greenland and as far south as South Africa and New Zealand (Fage, 1942; Tattersall, 1951).

There is only one specimen of *E. grimaldii* in our collection (Burns and Wigley, Table 2), taken at a deepwater station (700 m) along the continental slope off southern New England (Figure 2). This specimen was caught in a 12.2-m shrimp trawl equipped with a coarse-mesh (6.5 cm extension measure) net. Although the net was fished on bottom, it cannot be determined at what depth the specimen occurred. The low fishing efficiency of this trawl during setting and retrieval, however, lends support to the belief that it was caught on or near the ocean bottom.

This is only the second record of this species from off the eastern coast of the United States, even though it is moderately common in other areas and widely distributed throughout the world. Its occurrence in deep water over bottom sediments composed of silts and clays is typical for this species.

Suborder MYSIDA

Family MYSIDAE

Subfamily BOREOMYSINAE

Boreomysis tridens G. O. Sars, 1870

This is a moderately large species that is known to occur only in the North Atlantic Ocean. It is distributed along the eastern Atlantic Continental Slope from the Bay of Biscay

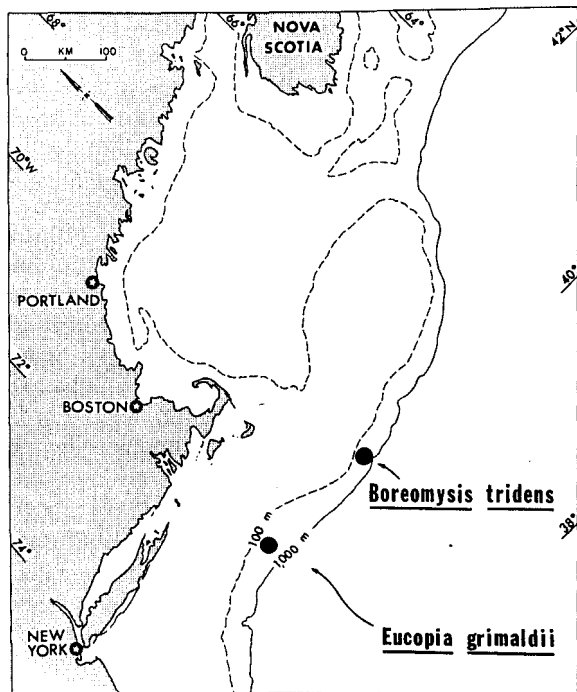


FIGURE 2.—Geographic distribution of *Eucopia grimaldii* and *Boreomysis tridens* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

north to Norway, across to the Faroe Islands, south and west of Iceland and Greenland, southward along the continental slope of North America (Tattersall and Tattersall, 1951). Tattersall (1951) lists over 20 records from off the northeast coast of the United States, ranging as far south as Delaware (lat 38°27' N).

This species was reported by Verrill (1885) as being common on the continental slope in the western Atlantic. The collections of this mysid reported by Tattersall (1951), all made by the research vessels *Albatross*, *Fish Hawk*, and *Challenger*, reflect its deepwater habitat.

Our collection contains one sample of this species consisting of three specimens (Burns and Wigley, Table 3). They were taken on the west side of Hydrographer Canyon, located about 130 km southeast of Nantucket, Mass. (Figure 2). The depth of water at this location is 402 m. Its occurrence at this depth and on bottom sediments of silty sand are characteristic for this species. Two specimens 15.0

and 16.5 mm in length are immature; a 26-mm specimen is an adult male.

Subfamily GASTROSACCINAE

Bowmaniella portoricensis Băcescu, 1968

B. portoricensis is morphologically very similar to *B. johnsoni* (Tattersall). A close examination of pleopod 3 in male specimens and of the uropod and the posterior part of the carapace in all specimens was required for reliable differentiation of these two species. *B. portoricensis* is a subtropical species that has been reported by Băcescu (1968) off the southeastern coast of the United States between Beaufort, N.C., and northern Florida. Although this species was known in only a few locations at the time of Băcescu's report, it is undoubtedly more common than these few published records suggest, as indicated by the relatively large number of samples in the NMFS collection. Its rather small size (up to 11-mm body length) and its occurrence in areas that have not yet been thoroughly studied presumably have contributed to the paucity of collections.

The NMFS collection contains 100 specimens of *B. portoricensis* from 46 samples, all of which are from off the southeastern coast of the United States (Figure 3; Burns and Wigley, Table 4). The northernmost samples were taken approximately 90 km north of Cape Hatteras, N.C., at lat 36° N. The southern limit of our samples is 15 km south of Ft. Pierce, Fla., at lat 27°20' N. All of these samples were collected within 125 km of the shoreline. Water depths at which they occurred range from 9 to 56 m, and most of them were taken at depths between 15 and 39 m.

Body lengths average 6.9 mm; the range in length is 3.1 to 10.0 mm.

This species is chiefly an inhabitant of sandy sediments. Sand was present at all stations. Shell was a major component at 7% of the stations and a minor component at 26% of the stations where *B. portoricensis* occurred.

Seven females, 7.9 to 10 mm in length, from the May and June samples were carrying larvae in the brood pouch. The number of larvae per clutch ranges from 1 (obviously an incomplete brood) to 30. Only the relatively advanced

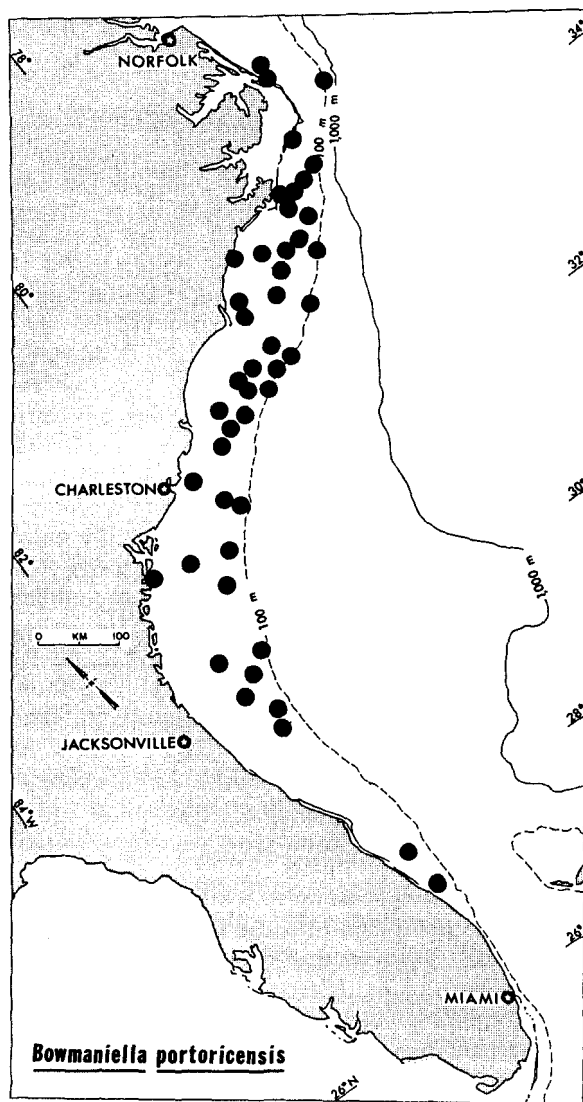


FIGURE 3.—Geographic distribution of *Bowmaniella portoricensis* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

larval stages—V, VI, and VII, with lengths from 1.0 to 1.2 mm—are represented. The presence of larvigerous females as well as immature specimens in May and June samples reveals that *B. portoricensis* spawns not only in early summer, but in the springtime as well.

The NMFS collection contains 31 males and 47 females, a ratio of 0.7 male to 1 female.

Anchialina typica (Krøyer, 1861)

This moderately small, stout mysid is widely distributed in both the Atlantic and Pacific Oceans. It has been reported from the Pacific near the central (Hawaii and Gilbert Islands) and southwestern (China Sea to Great Barrier Reef) regions. According to Tattersall (1951) it is abundant in the region of the Philippine Islands and the East Indies. Though it has been reported in the North Atlantic from south of Newfoundland (Nouvel, 1943), records from the vicinity of the Bahama Islands and Cuba are the most common. Many occurrence records in the literature are based on specimens collected in surface waters.

The NMFS collection contains three specimens from three different stations (Figure 4;

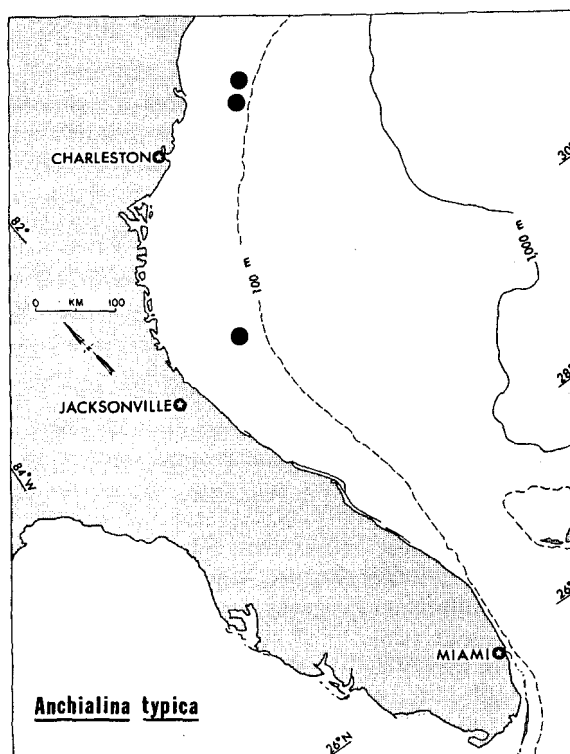


FIGURE 4.—Geographic distribution of *Anchialina typica* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

Burns and Wigley, Table 5). The southernmost sample is from off northern Florida. The other two samples were taken 60 to 70 km east of Georgetown, S.C. All specimens are males 4.5 to 5.0 mm long. They were all collected with the Campbell grab in rather shallow water, between 32 and 38 m. Bottom sediments at these stations are composed of fine and medium sand. These are the first records of this genus and this species from the shallow shelf region off the eastern coast of the United States.

A closely related species, *A. agilis*, is an active swimmer that migrates to surface waters at night and descends to deep water before day-break (Russell, 1925). Based on NMFS records of *A. typica* reported herein, and on Tattersall's (1951) records, it appears likely that *A. typica* in the shallow and moderately shallow regions of the continental shelf may also dwell on bottom during the day and rise to surface or near surface waters at night.

Subfamily MYSINAE

Tribe ERYTHROPINI

Erythropus erythropthalma (Göes, 1864)

Geographic Distribution

This colorful mysid species has a widespread distribution on the continental shelf and upper portion of the continental slope in Arctic seas and the North Atlantic Ocean. In eastern Atlantic waters it extends from the Arctic southward to the British Isles. In the western Atlantic it has been reported from off Greenland, eastern Canada, and off the northeastern United States as far south as Delaware (Gardiner, 1934; Bigelow and Sears, 1939; Tattersall, 1951; Tattersall and Tattersall, 1951).

The NMFS collection contains 187 samples totaling 4,573 specimens of this species (Figure 5; Burns and Wigley, Table 6). These samples were collected on the continental shelf and slope between southeastern Nova Scotia and Long Island, N.Y. By far the largest number of samples is from the southern part of Georges Bank. A moderate number of samples were taken in the offshore southern New England area south

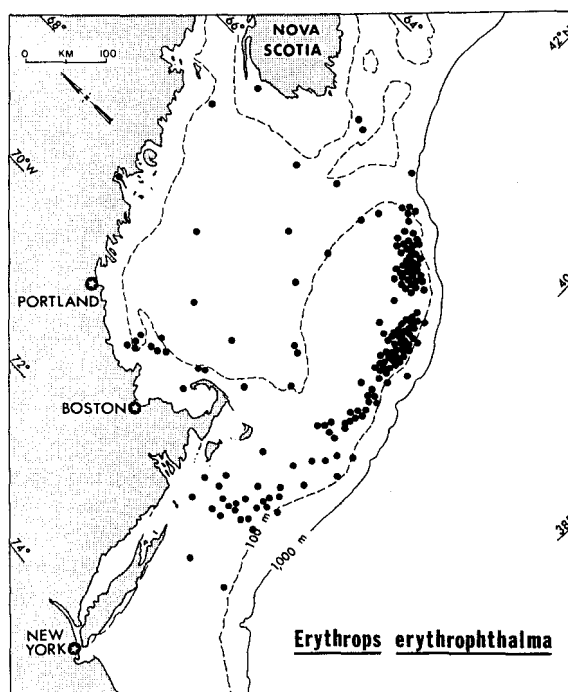


FIGURE 5.—Geographic distribution of *Erythropus erythropthalma* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

of Rhode Island and eastern Massachusetts. The common occurrence of this species on Georges Bank was somewhat unexpected in view of the fact that Whiteley (1948) found it to be a minor component in plankton samples collected there in 1939-41.

Bathymetric Distribution

This is an offshore species that occurs chiefly in mid- to outer-shelf depths. The shallowest record in published accounts that we have seen is 12 m, reported by Procter (1933) for specimens collected on the coast of Maine. Deepest record previously reported is 275 m, from the Gulf of St. Lawrence (Tattersall, 1957). Depth range for samples in the NMFS collection is 18 to 421 m (Table 1).

A large proportion (78% of the samples and 90% of the specimens) were taken at midshelf depths, 60 to 100 m. The sample from unusually

TABLE 1.—Bathymetric distribution of *Erythrops erythrophthalma*, based on the NMFS collection.

Water depth	Samples	Specimens
m	Number	Number
0- 19	1	1
20- 39	1	2
40- 59	13	277
60- 79	73	1,676
80- 99	72	2,422
100-119	12	133
120-139	4	6
140-159	4	33
160-179	3	17
180-199	1	1
200-219	1	2
220-239	1	1
420-439	1	2
Total	187	4,573

deep water was collected at the head of Lydonia Canyon, along the southwestern edge of Georges Bank. This sample consisted of two specimens, one adult female and an immature, collected in a stramin-mesh ring net towed 1 to 2 m above the sea bottom.

Spawning

Seven ovigerous specimens are present only in the August samples, and 11 larvigerous specimens are present in August and September samples. This is an unusually small number of specimens (about 1%) in spawning condition compared with the total number of adult females. Furthermore, the spawning females are not especially large. Their average length is 6.4 mm, range 5.7 to 7.1 mm. Larger specimens taken during the same month and at other seasons are not in spawning condition. The presence of immature specimens of about 4 to 5 mm in length throughout the period from June through December implies an extended spawning season during the warmer part of the year, plus the possibility of spawning during other seasons as well. The absence of well-defined length modes from month to month also supports the hypothesis of a lengthy spawning period.

The number of eggs per clutch ranges from 1 to 6, and the number of larvae from 2 to 15. The lower values appear to represent incomplete broods that resulted from losses incurred during the catching and processing procedures.

In summary, the available evidence from the NMFS material suggests that only a small part of the population spawns at one time and that spawning takes place throughout a large part of the year—possibly from spring through fall or longer.

Sex Ratio

The NMFS collection contains 1,536 males and 1,692 females, a ratio of 0.91 male to 1 female.

Body Size

The eggs are nearly spherical and average 0.4 mm in diameter. Larvae of stage V are 1.2 mm long, and stage VII are 1.4 mm. Immatures range in length from 3.0 to 6.1 mm. Mature specimens have an overall size range from 4.3 to 9.6 mm. Size range during various seasons, separated by sexes, are:

Season	Males	Females
Mar.-Apr.	6.4	6.1
May-June	5.2-7.5	5.8-7.0
July-Aug.	5.1-8.3	5.0-9.0
Sept.-Oct.	4.8-9.6	4.3-8.7
Nov.-Dec.	5.1-8.9	5.0-8.9

A size comparison of mature males with mature females from the same samples discloses that males are 0.3 to 0.4 mm larger than females.

The minimum size of adults is generally larger in the early summer, decreases in late summer and fall, then increases again in early winter. This is due to an earlier maturation of immature individuals during the period when water temperatures are comparatively high. The trend for maximum size of adults is just the opposite. Maximum length is smallest in early summer, increases in the late summer and fall, and (the males only) decreases again in early winter. It is not clear whether this sequence in size differences results solely from faster growth during the warm season, or whether a summer generation has reached the culmination of its life span in September-October.

Length of Life

An analysis of body length measurements did not disclose trends in growth or separate length-frequency modes that indicated year classes. Immature specimens with an average length of roughly 4.5 mm are present in June, August, September, November, and December. The mature groups of both males and females in these same months are mostly between 5 and 7 mm long and do not exhibit the expected increases in size as the seasons progress. Our tentative conclusion is that *E. erythrophthalma* has a short life span, a rapid growth rate, and a lengthy spawning season.

Relation to Bottom Sediments

Members of this genus are considered to dwell on or near the sea bottom, and our catch records substantiate this view. It is uncommon in plankton samples collected in the upper water layers, but is regularly taken in hauls collected near bottom. It occurred most frequently and in greatest abundance on sand sediments (Table 2). Seventy-seven percent of the samples and over 90% of the specimens were taken on, or over, sand sediments. A moderate number of samples (10%) were taken in areas of fine-grained sediments. Furthermore, it should be added that most of the sediments along southern Georges Bank, where the majority of samples were taken, contain modest amounts of silt, generally between 1 and 10%. These quantities are insufficient to be incorporated in the bottom type ter-

minology (Shepard, 1954). Although these are small quantities, the presence of silt on the sediment surface makes it readily available to the mysids. Furthermore, this species is common on the silty sediments in the region south of Martha's Vineyard, Mass. Thus *E. erythrophthalma* appears to inhabit sediments containing a small to moderate amount of silt, in contrast to *N. americana* and *M. bigelowi*, which are more common in sediments having a very low silt content.

Meterythrops robusta S. I. Smith, 1879

This rather large but uncommon species has a wide distribution in boreal and subarctic waters. In the Atlantic region it has been reported from the Kara Sea, Spitsbergen, Norway, Greenland, Gulf of St. Lawrence, and in the Gulf of Maine as far south as Cape Cod, Mass. In the Pacific it occurs in the area between Alaska and Washington. Moreover, assuming that *M. microphthalma* is a synonym for *M. robusta* (see Banner, 1954), then its distribution also includes the region off the east coasts of Japan and Korea (Tattersall, 1951).

The NMFS collection contains nine specimens from six stations, all from the periphery of the Gulf of Maine (Figure 6; Burns and Wigley, Table 7). Four specimens were collected at one station in the channel north of Browns Bank; three specimens were from three stations north of Great South Channel; and two specimens were taken off eastern Massachusetts.

Bathymetric distribution ranged from 64 to 150 m, and all specimens except one were from depths between 110 and 150 m.

The type of bottom sediments inhabited by this species is distinctive. The bottom sediments contained gravel at five of the six stations where *M. robusta* occurred. Three of the samples were taken on glacial till; one sample was from sandy gravel; one sample was from gravel; and one sample was from silt-clay. All other offshore species of mysids in the NMFS collection are associated with sand or finer grained sediments.

All specimens of *M. robusta* in the NMFS collection were caught in stramin nets or natu-

TABLE 2.—Frequency of occurrence of *Erythrops erythrophthalma* in various types of bottom sediments, based on the NMFS collection.

Bottom type	Samples	Specimens
	Number	Number
Rock-gravel	6	122
Gravel-sand	6	13
Glacial till	2	12
Sand	144	4,224
Sand-silt	12	50
Silt-clay	17	152
Total	187	4,573

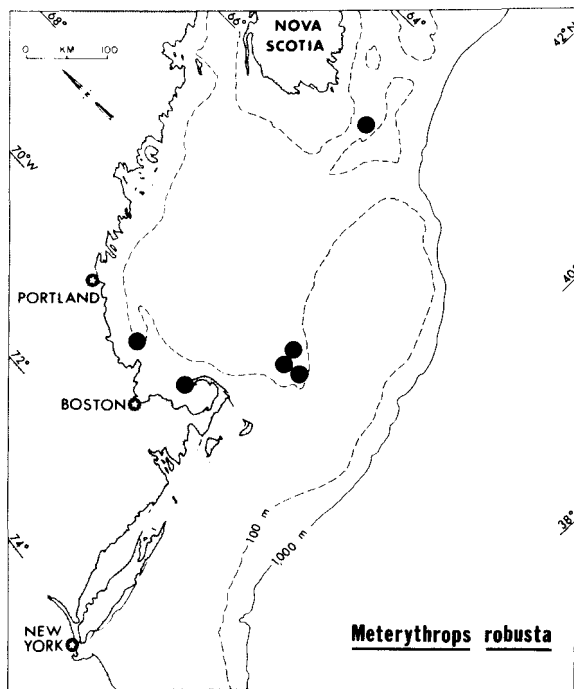


FIGURE 6.—Geographic distribution of *Meterythrops robusta* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

ralists dredges towed along the sea bottom. From this we infer that this species probably inhabits the sea bottom or the water stratum closely adjacent to bottom.

Body length of immature specimens ranged from 6.6 to 7.5 mm, young males 8.5 to 12.0 mm, and young females 8.6 to 9.3 mm. There were no large specimens in the NMFS collection that compare in size with the 28.5-mm adult male reported by Smith (1879) from the Gulf of Maine.

The six adult specimens included four males and two females, a ratio of two males to one female.

No definite information pertaining to spawning is available from the material in our collection. Both females are young and without external eggs. The only evidence on this subject is the presence of immature and young specimens in the August collections, which implies a spring spawning season.

Hypererythrops caribbaea Tattersall, 1937

This species is distributed along the east coast of North America from Maine to the Caribbean Sea. It has been reported from the outer continental shelf and upper slope at depths between 214 to 402 m (Tattersall, 1951). Apparently it is an uncommon species, since it has been reported previously from only seven stations. Body size is moderately small; lengths range from about 8 to 13 mm.

The NMFS collection contains three specimens from three locations (Figure 7; Burns and Wigley, Table 8), between the southern Gulf of Maine and the continental shelf margin south of Rhode Island. This southernmost sample is from a depth of 179 m; the others are from 168 to 179 m. The smallest specimen, 5.5 mm body length, is immature; the other two, 9.5 to 11.0 mm, are adult females. The largest specimen is larvigerous with an incomplete brood

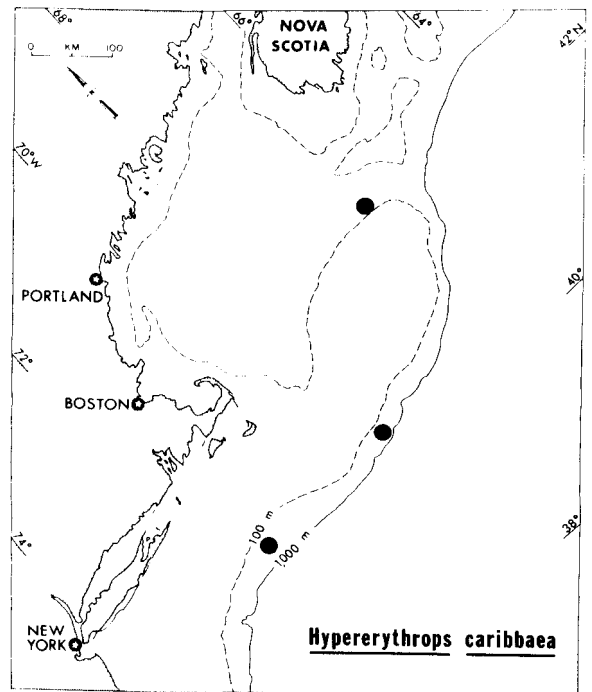
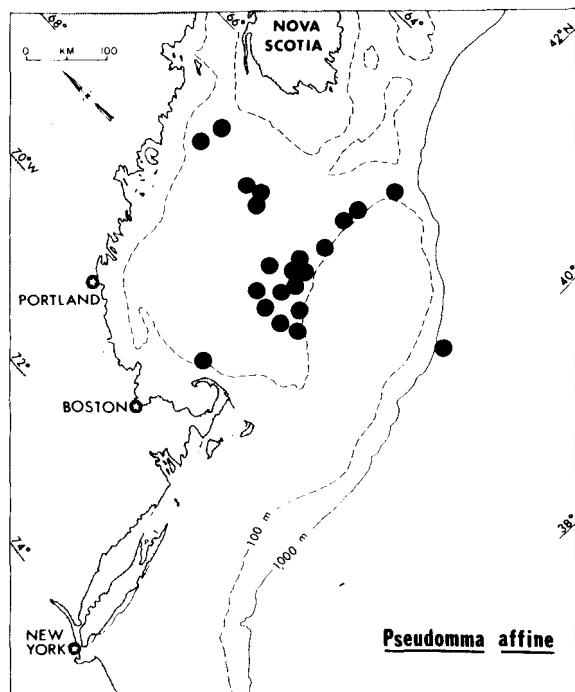


FIGURE 7.—Geographic distribution of *Hypererythrops caribbaea* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

of only two young in the brood pouch. Collection of this specimen in August indicates a summer spawning season for this species. This larvigerous specimen was found in the stomach of a Gulf Stream flounder, *Citharichthys arctifrons* Goode. Since *H. caribbaea* is found in warm-temperate waters, its occurrence in the Gulf of Maine may be restricted to the deeper basin areas where water temperatures are ameliorated by the intrusion of relatively warm, high-salinity slope water.

Pseudomma affine G. O. Sars, 1870

The geographic distribution of this species extends from the Bay of Biscay northward to Norway, westward to Iceland, Greenland, and North America. We found only two records of its occurrence in North American waters. Tattersall (1951) recorded one specimen taken by the research vessel *Fish Hawk* at station 999, located 153 km south of Rhode Island (lat 39°45' N, long 71°30' W) at a depth of 487 m. Klawe (1955) reported taking this species 2 km off Campobello Island, New Brunswick, Canada.



Bathymetric range of all records from the North Atlantic Ocean is 80 to 914 m.

Our collection contains 119 specimens from 22 samples (Figure 8; Burns and Wigley, Table 9), all from the Gulf of Maine, except one from just south of Georges Bank. They were collected at moderate water depths: 146 to 329 m. Bottom sediments at these collecting sites contain large proportions of fine particles, chiefly silts, clays, and fine sands. Only two samples were taken in areas having gravel or coarse sand bottom.

Body lengths range from 4.0 to 13.1 mm; the majority are between 8 and 11 mm.

Evidence of an extended spawning season is provided by the presence of ovigerous, larvigerous, and small juvenile specimens in the collection. A 10.9-mm ovigerous specimen was taken in December (*Albatross III*, cruise 70, station 41) with 11 eggs and an average egg diameter of 0.4 mm. One 11.0-mm larvigerous specimen taken in August (*Albatross IV*, cruise 65-11, station 56) contains one larva 1.2 mm long. Additionally, juveniles 5 mm or less in length were taken in August, November, and December. Spawning thus takes place during summer and winter and may also occur in the spring and fall.

Sex ratio of the specimens in the NMFS collection is 2.3 males (68 specimens) to 1 female (29 specimens).

Several morphological features in our specimens differ slightly from published descriptions of this species. In Table 3 are listed the number of spines on the telson and relative length of the antennal scale apex and relative width of the antennal scale. Specimens in our collection have fewer apical spines (nearly always 6) on the telson, and a greater number of spines (9-24, average 17) on the lateral margins of the telson, than specimens from the eastern Atlantic. Also, the antennal scales on Gulf of Maine specimens have a proportionately longer apex (that portion of the scale between the spine cleft and the anterior end) than eastern Atlantic specimens. Spination of the telson and shape of the antennal

FIGURE 8.—Geographic distribution of *Pseudomma affine* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

TABLE 3.—Number of spines on the telson and the proportional measurements of the antennal scale for individual male and female specimens of *Pseudomma affine* of various sizes.

Body length mm	Spines on telson		Antennal scale	
	Apex	Lateral ¹	Relative length of apex ²	Relative width ²
	Number	Number	%	%
Males				
8.0	6	15	31	29
10.0	6	17	34	25
10.3	6	19	36	27
13.0	8	24	37	29
Females				
4.3	6	9	28	32
7.0	6	13	33	33
7.3	6	--	36	31
10.4	6	21	40	29
10.5	6	19	44	30
12.0	6	18	42	30

¹ Total count of lateral spines from both sides of the telson.

² Measurements expressed as percentages of the antennal scale length.

scale change as the specimens increase in size. The number of lateral spines on the telson increases with body length, particularly in males. In both males and females the apex of the antennal scale is proportionately longer in larger specimens.

Sexual dimorphism is rather slight in the characters listed in Table 3. Females have a relatively larger antennal scale apex and a slightly broader antennal scale than males.

The close affinity of *P. affine* with *P. roseum* G. O. Sars necessitated considerable effort to establish the identity of the specimens at hand. In addition to the taxonomic characters mentioned above, specimens in our collection were distinguished from *P. roseum* by: the relatively broad telson and an ocular plate that has a broad, gently rounded anterolateral "corner" with serrations extending along a large portion of the lateral margins. The practice of using morphological characters that change with size or vary according to sex or stage of maturity has led to confusion between these species. Further taxonomic studies of these two species are clearly in order.

Pseudomma sp.

Ten specimens of *Pseudomma* that do not correspond morphologically to any known species

are represented from three localities off southern New England. A description of this species and notes on its ecology is being prepared and will be reported elsewhere.

Amblyops abbreviata (M. Sars 1869)

This widely distributed boreal mysid occurs in both the North Atlantic and North Pacific Oceans. In the Pacific it has been found off Japan and off the west coast of North America from Washington to Alaska. In the Atlantic it ranges from the Bay of Biscay north to Scandinavia, west to Greenland and North America. Previous records from the northeastern coast of the United States consist of 38 specimens from 7 offshore stations situated between Cape Cod, Mass., and northern New Jersey. These specimens were collected by the U.S. Fish Commission between 1879 and 1881 at water depths between 238 and 838 m.

Our collection contains 34 specimens from 8 samples taken in the Gulf of Maine, primarily in the southern part of the Gulf (Figure 9; Burns and Wigley, Table 10). Water depths at these localities range from 183 to 329 m. The bottom sediments where these specimens were taken are composed predominantly of silts, clays, and fine sands; one exception is a sandy gravel bottom off the eastern end of Georges Bank where one juvenile specimen was obtained. Body length ranged from 4.7 to 15.0 mm. The size of adults is 10 to 15 mm; the males tend to be slightly larger (average length 12.9 mm) than females (average length 12.3 mm).

Spawning occurs during winter and possibly in other seasons as well. One ovigerous female collected in December (*Albatross III*, cruise 70, station 25) had 29 eggs in the marsupium, each 0.4 mm in diameter. The presence of juvenile specimens 4 to 6 mm in length in August and an 8-mm specimen in December suggests that spawning also takes place in summer and fall.

Sex ratio of the specimens in the NMFS collection is 0.65 male (11 specimens) to 1 female (17 specimens).

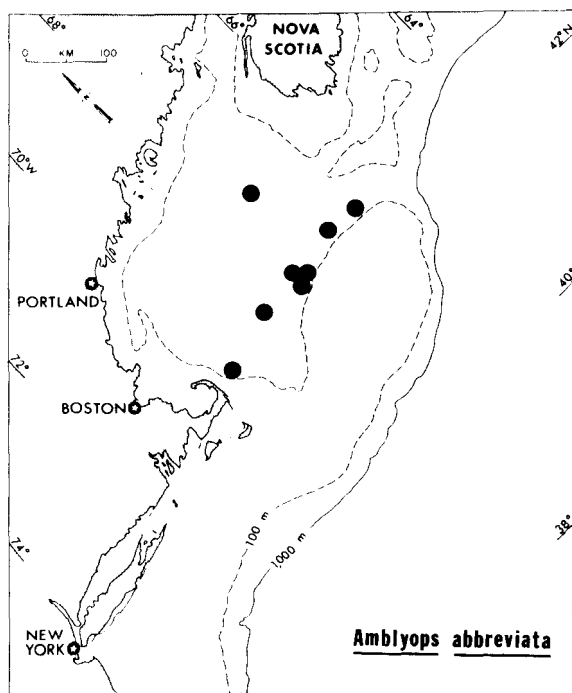


FIGURE 9.—Geographic distribution of *Amblyops abbreviata* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

between Hudson Canyon and Hydrographer Canyon—in the same area where they were found to be most common by the *Fish Hawk* and *Albatross* (Figure 10; Burns and Wigley, Table 11). The depth range of their occurrence is 220 to 366 m. Because two samples were collected with the bottom skimmer, it is certain these specimens were present on the sea bottom at the time of capture. Their presence on the bottom during hours of low light level, 1600 to 2200 hr, suggests they may not undertake a diurnal vertical migration. Five specimens are adults, 13.0 to 16.2 mm long, and three specimens are immature, 4.0 to 6.0 mm long. We have no information on spawning other than the presence of 4- to 6-mm specimens in June, from which a spring spawning may be inferred. Bottom sediments at the collecting sites are fine-grained types: sand, silt, and silt-clay.

Tribe LEPTOMYSINI

Bathymysis reniculata Tattersall, 1951

This large-eyed species of *Bathymysis*, which occurs only in the western Atlantic Ocean, has been reported from southern New England to the southern tip of Florida (Tattersall, 1951). The principal area of occurrence is along the outer continental shelf and upper slope between Hudson Canyon and Hydrographer Canyon (southeast of Nantucket, Mass.). The bathymetric range reported for this species is 220 to 483 m. These records are based on collections made by the research vessels *Fish Hawk* and *Albatross* during the latter part of the last century.

The NMFS collection contains eight specimens from three stations off southern New England

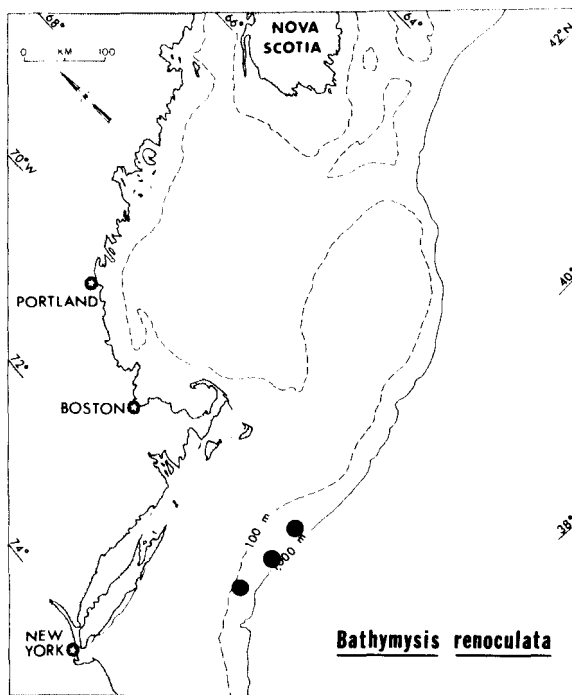


FIGURE 10.—Geographic distribution of *Bathymysis reniculata* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

Mysidopsis bigelowi Tattersall, 1926

Geographic Distribution

M. bigelowi is a small American species that occurs along the Atlantic and Gulf coasts of eastern and southern United States from New England to Louisiana.

The NMFS collection contains 2,031 specimens out of 54 samples (Figure 11; Burns and Wigley, Table 12) collected from northeastern Georges Bank southward along the coast to the vicinity of Jacksonville, Fla. Georges Bank is the principal area represented in the sampling; the results extend the known range of this species a considerable distance to the northeast. Only five samples were from localities south of the Nantucket Shoals region: these were taken off New Jersey, Virginia, North Carolina, and northern Florida.

It is interesting to note this species is not listed as present in the plankton samples collected from Georges Bank between 1939 and 1941 (Whiteley, 1948). Although the absence could have been due to annual fluctuations in abundance in this northern sector of its range, our results show the species was present each year we conducted moderate or heavy sampling: in 1955 through 1958, and in 1964 through 1967. More likely the absence in the 1939-41 samples resulted not from temporary fluctuations but because these earlier collections were primarily from middle and upper water levels, whereas most of the NMFS collections were taken on or near the sea bottom.

Bathymetric Distribution

M. bigelowi is a shallow-shelf species that has been reported from inshore localities such as the inlet to Indian River Bay, Del., and Calcasieu Pass, La., and from offshore waters as deep as

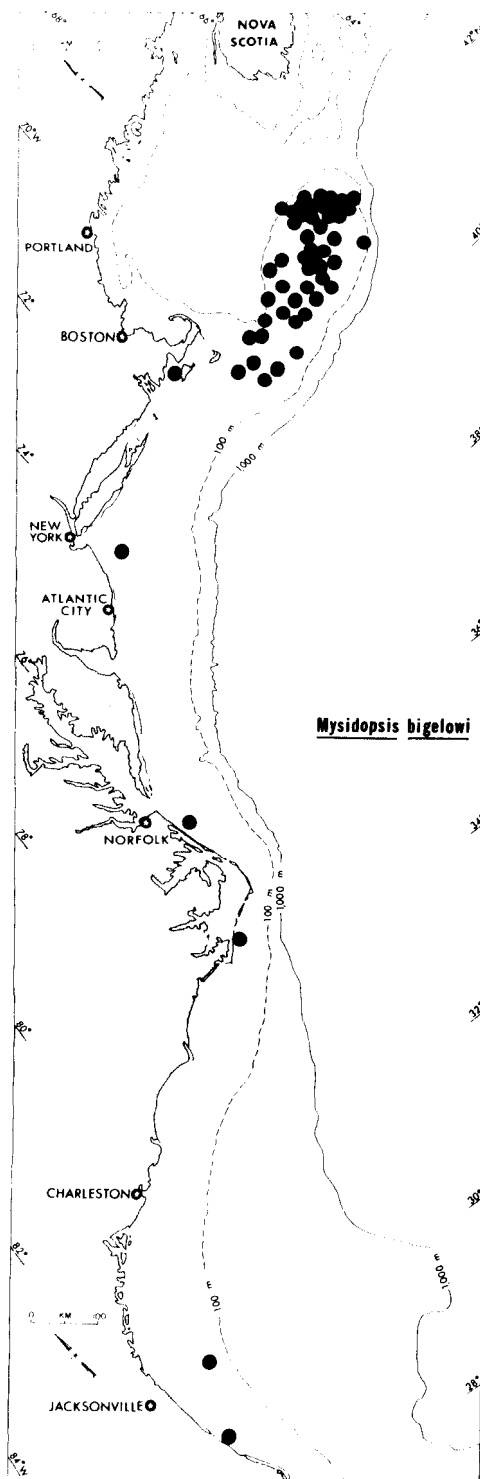


FIGURE 11.—Geographic distribution of *Mysidopsis bigelowi* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

77 m (Tattersall, 1951; Grice and Hart³; Hopkins, 1965).

Depth range of the NMFS samples is from 13 to 179 m. By far the largest number of samples (73%), greatest number of specimens (91%), and highest densities occur between 30 and 80 m (Table 4). One collection taken at an unusually deep locality, 179 m, is from the northern edge of Georges Bank. The water circulation in this area and its proximity to shallow waters commonly inhabited by this species may account for its presence at that relatively great depth.

TABLE 4.—Bathymetric distribution of *Mysidopsis bigelowi*, based on the NMFS collection.

Water depth	Samples	Specimens
m	Number	Number
10- 19	4	28
20- 29	3	10
30- 39	9	557
40- 49	8	493
50- 59	9	640
60- 69	7	73
70- 79	6	85
80- 89	4	22
90- 99	2	116
100-109	1	1
170-179	1	6
Total	54	2,031

Spawning

This species spawns from April to November in the coastal areas of Delaware (Hopkins, 1965). There is no information about spawning habits of the offshore and northern populations, and we did not find a single ovigerous or larvigerous specimen in the NMFS collection. We do, however, have immature specimens represented in samples collected in May, August, September, November, and December. This is indicative of a long spawning season, probably from early summer through fall.

The large size of immatures, 4.0 to 5.0 mm, in May samples is believed to represent the overwintering young. The absence of ovigerous fe-

males in the many large samples collected in December is evidence that spawning most likely has terminated by that time of year.

Sex Ratio

The NMFS collection contains 313 males and 195 females, a ratio of 1.6 males to 1 female.

Body Size

This species is the smallest mysid in the NMFS collection. A summary of body length data by month of capture for males, females, and immatures is given in Table 5. Range in body length among all specimens in the collection is 2.4 to 6.6 mm. The average length of immatures is 3.8 mm, males 4.9 mm, and females 5.1 mm. Members of this species were found to mature at 3.5 mm, smaller than any other species in the NMFS collection.

TABLE 5.—Means and ranges of body length of *Mysidopsis bigelowi* by months and sexes.

Month	Body length					
	Immatures		Males		Females	
	Mean	Range	Mean	Range	Mean	Range
	mm	mm	mm	mm	mm	mm
May	4.6	4.0-5.0	5.1	4.9-5.7	5.5	5.4-5.7
Aug.	4.0	--	4.9	4.2-6.6	4.5	3.8-5.8
Sept.	3.0	--	4.6	--	5.0	--
Nov.	3.8	2.4-4.1	5.2	4.6-5.7	5.1	4.0-6.3
Dec.	3.5	2.4-4.5	4.8	3.5-5.8	4.5	3.5-5.6

Length of Life

Our samples are inadequate to give an accurate estimate of the length of the life cycle. The few available clues, such as the presumably long spawning season and the large size of the overwintering immatures, are suggestive of a life cycle similar to *Neomysis americana*: a short-lived summer generation and a long-lived winter generation.

Relation to Bottom Sediments

Many specimens in the NMFS collection were taken with bottom samplers (Smith-McIntyre, Van Veen, and Campbell grabs) or gear that

³ Grice, George D., and Arch D. Hart. 1962. The abundance, seasonal occurrence and distribution of the epizooplankton between New York and Bermuda. Appendix to Ref. 62-4, Woods Hole Oceanogr. Inst. (Unpublished manuscript.)

sampled water layers adjacent to the sea bed (sled net). These results suggest *M. bigelowi* lives in or on the bottom sediments during much of its life.

An analysis of the types of bottom sediments at the collecting sites reveals a high incidence of this mysid on various grades of sand (Table 6), usually sand containing little or no silt or clay. They tend to avoid fine-grained sediments as further evidenced by their absence in several hundred samples taken from a 1,000 square km area of predominantly silt and sandy-silt sediments south of Martha's Vineyard, Mass., on research vessel *Delaware* cruise 62-7.

TABLE 6.—Frequency of occurrence of *Mysidopsis bigelowi* in various types of bottom sediments, based on the NMFS collection.

Bottom type	Samples	Specimens
	<i>Number</i>	<i>Number</i>
Rock-gravel	4	177
Gravel-sand	1	1
Shell-sand	1	1
Sand	44	1,847
Sand-silt	1	1
Unclassified	3	4
Total	54	2,031

Relation to Water Temperature

M. bigelowi inhabits water temperatures from about 2° C in the northern part of its range to summer water temperatures of about 30° C in the Florida and Louisiana areas. The annual change in temperature is slightly less than 20° C in the north and slightly more than 20° C in the south.

Mysidopsis furca Bowman, 1957

This species was described by Bowman (1957) from a sample containing 23 specimens collected in 1953 by the research vessel *Theodore N. Gill*. The specimens were obtained at one station (number 57) located 40 km from shore off the northern coast of South Carolina. Depth of water at the collecting site is 22 m. It was later reported by Brattegard (1969) from off south-eastern Florida at depths of 1 to 48 m.

The NMFS collection contains one specimen, a female 4.2 mm long, taken with the Campbell

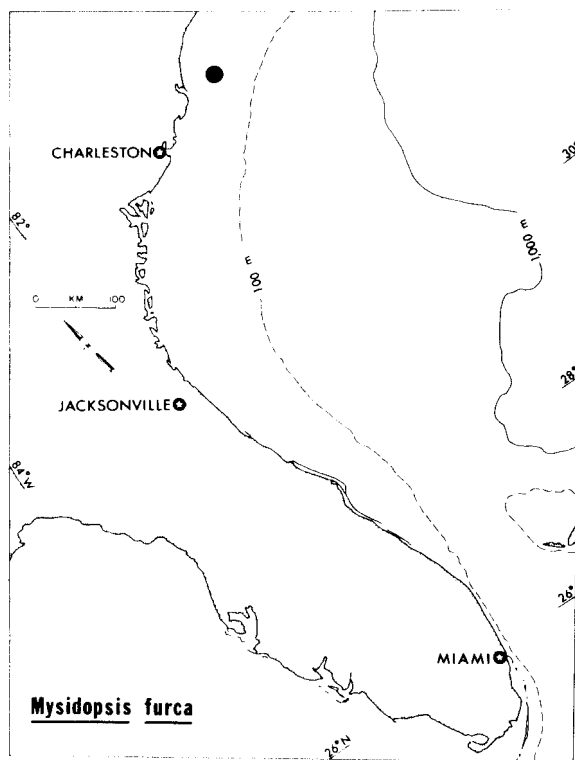


FIGURE 12.—Geographic distribution of *Mysidopsis furca* based on a specimen in the collection at the NMFS Biological Laboratory, Woods Hole.

grab 50 km east of Georgetown, S.C., (Figure 12; Burns and Wigley, Table 13) about 50 km southwest of the type locality. The specimen was taken at a depth of 22 m on sediment composed of fine sand. This small species has a reported size range of 4.6 to 6.1 mm (Bowman, 1957). Neither the size nor the developmental stage of the NMFS specimen provides any indication of spawning season or size at maturity.

Promysis atlantica Tattersall, 1923

This rare species was described from an immature female specimen collected off Rio de Janeiro, Brazil, in 1910 (Tattersall, 1923). It was not reported again until Clarke (1956) described the male and adult female, and gave new records of occurrence for specimens col-

lected off the coasts of Louisiana, South Carolina, and North Carolina.

The NMFS collection contains three specimens from three stations located off the southeastern coast of the United States (Figure 13; Burns and Wigley, Table 14). Their geographic distribution is from just north of Cape Hatteras,

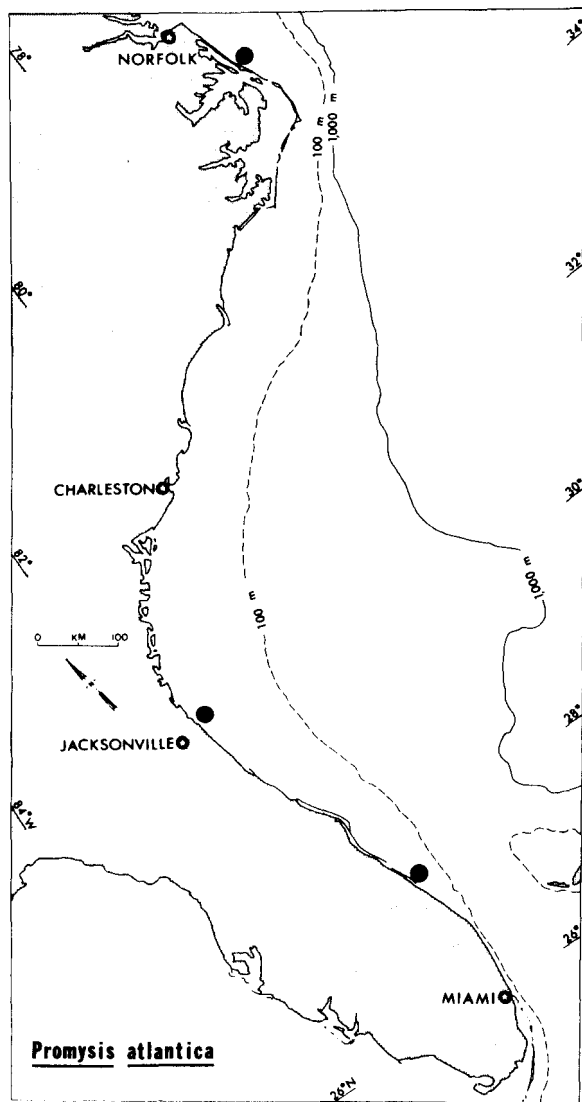


FIGURE 13.—Geographic distribution of *Promysis atlantica* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

N.C., to Fort Pierce, Fla. Size range is 4.5 to 5.0 mm; all are females. They were taken in shallow water, 8 to 26 m, on sandy sediments. Little is known about the biology of this species, and the few specimens in the NMFS collection provide no additional information on spawning or length of life.

Tribe MYSINI

Mysis mixta Lilljeborg, 1852

This boreal mysid occurs in the Eastern Atlantic region from the White Sea, Spitsbergen, Scandinavia and southward to the Baltic Sea, and westward to Iceland. In the Western Atlantic region it has been reported from Greenland, eastern Canada, and the eastern coast of the United States as far south as Cape Cod, Mass. In the Gulf of Maine it has been most frequently reported from off the eastern coast of Massachusetts and from a few localities off the Maine coast (Smith, 1879; Rathbun, 1905; Tattersall, 1951; and others).

This species is represented by 382 specimens from 45 samples in the NMFS collection (Figure 14; Burns and Wigley, Table 15). The majority of specimens, including all adults, were taken in the western part of the Gulf of Maine between Cape Cod, Mass., and the central Maine coast. The first records of this species from south of Cape Cod were collected in the region off Rhode Island and southeastern Long Island, N.Y. The location of the southernmost sample is lat 40°36' N and long 71°33' W, approximately 55 km southeast of Montauk Point, N.Y. All 26 specimens from these six southern samples are immatures 10.5 to 20.1 mm in length; they were collected in June and September.

Water depths at all NMFS collecting sites range from 29 to 159 m. Bottom sediments at these localities consist of a variety of types ranging from fine-textured clays to gravel. Most of the samples, however, come from intermediate types of sediment: silt-clay (38%), glacial till (27%), and sand (22%). Only a small percentage of samples represent other bottom types: silt-sand (7%), gravel (4%), and clay (1%).

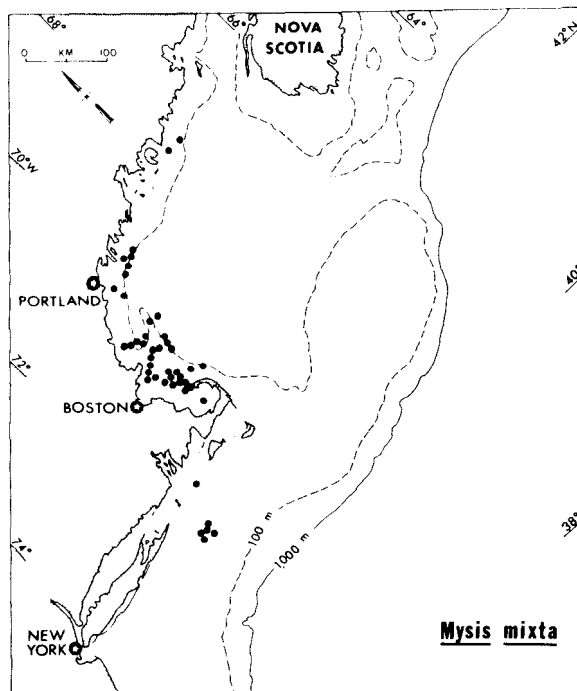


FIGURE 14.—Geographic distribution of *Mysis mixta* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

The occurrence of specimens at the surface (*Albatross IV*, cruise 66-14, station 24) and in several samples between middepths and surface (*Albatross IV*, cruise 66-14, stations 35, 36, 39, and 40), as well as those taken on the sea bottom, indicates a diurnal vertical migration. Specimens at the surface were collected at 0300 hr and midwater samples were taken between 2100 and 0900 hr. This implies inhabitation of upper waters during hours of darkness and a bottom habitat in the daytime.

Sex Ratio

The NMFS collection contains 119 females but only 2 males, which is a ratio of 0.017 male to 1 female. Whether males occur in a habitat different from females, or are actually so much less abundant than females, is unknown. This is the only species in the collection having such a grossly unbalanced sex ratio.

Body Size

Body lengths range from 5.0 to 25.0 mm. Immature specimens are a common component, accounting for 69% of all specimens caught. Many of these immature specimens are large (15 to 20 mm). Also noteworthy is that many large males and females do not possess fully developed secondary sex characteristics. A summary of body length measurements by months and stage of development is listed in Table 7.

TABLE 7.—Means and ranges of body length of *Mysis mixta* by months and stages of development.

Month	Body length			
	Immatures		Adults	
	Mean	Range	Mean	Range
	mm	mm	mm	mm
May	6.9	5.0- 8.5	20.6	19.0-21.3
Jun.	10.5	--	--	--
Aug.	13.6	10.3-20.0	22.0	20.0-24.2
Sept.	18.8	17.2-20.1	--	--
Oct.	16.7	14.0-20.0	23.4	22.0-25.0

Length of Life and Spawning

Although Smith (1879) suggested this species might be an annual that spawns during the winter, our analysis of the maturity status and size frequency data of the NMFS specimens leads us to believe that *M. mixta* has a 2-year life span and spawns in winter or early spring.

Our material is scanty for purposes of determining length of life, but the data do indicate a clear trend in growth and development (Table 7). The specimens reveal two definite age groups in both spring and fall. In May the immatures average 6.9 mm and the adults 20.6 mm. In October the immatures average 16.7 mm and the adults 23.4 mm. Juveniles increase in length at a rate of about 2 mm per month until winter when the growth rate slows appreciably. They mature and spawn in the winter or early spring.

None of the NMFS specimens are ovigerous. The only indication of spawning season is the presence of small (5.3 to 6.3 mm) specimens in May, which suggests a late winter or early spring spawning.

Mysis stenolepis S. I. Smith, 1873

This large American mysid is distributed in coastal waters of northeastern North America from the Gulf of St. Lawrence to New Jersey. Though very common to this region it is represented by only a few specimens in the NMFS collection because biological samples were rarely collected in the intertidal and shallow subtidal zones.

The NMFS collection contains 13 specimens from six samples (Figure 15; Burns and Wigley, Table 16), all from a rather small area off eastern Massachusetts and eastern Rhode Island. The specimens were collected with a dip net along shore in water depths of about 1 m. Four samples were taken in beds of *Zostera* or algae, and one sample was from a sandy bottom (bottom type for the other sample is unknown).

M. stenolepis is one of the largest shallowwater species in the NMFS collection. Body lengths

of these specimens range from 13.0 to 26.0 mm, and average 20.4 mm.

According to Smith (1879) the life span of this species is one year. Their life cycle is as follows: (1) adults spawn in winter and early spring, (2) the young appear in late spring and summer, and (3) they mature in the fall and winter. Material in the NMFS collection substantiates this life-cycle plan. Body lengths of specimens, by months, are:

Month collected	Average body length (mm)	Stage of maturity
September	14.2	Immature
October	20.0	Mature
November	24.2	Mature
February	25.3	Mature
March	25.0	Mature
April	26.0	Mature

Three larvigerous specimens collected in February and March range in size from 25.0 to 25.5 mm.

Fecundity of this species is very high compared with other east coast mysids. An ovigerous-larvigerous specimen 25.0 mm long, collected in late February, held 94 eggs and 50 stage III larvae in the brood pouch. Average diameter of the eggs is 0.4 mm and average length of the larvae is 1.4 mm. A 25.5-mm long larvigerous female from the same sample was carrying 188 stage IV larvae; their average length is 1.4 mm. A 25.0-mm larvigerous female collected in March was carrying 171 stage VII larvae; their average length is 1.86 mm.

A rather high water temperature was noted when the September 4, 1961, sample of *M. stenolepis* was collected. The temperature was 23.9° C at a depth of 1 m in an eelgrass bed in Waquoit Bay, Falmouth, Mass. This is the highest temperature recorded for the NMFS samples of this species.

Praunus flexuosus (O. F. Müller, 1776)

This species is very common in shallow coastal waters of Great Britain and along the northern coast of France, Holland, and southern Scandinavia (Tattersall and Tattersall, 1951). In 1960 it was discovered in the harbor at Barnstable,

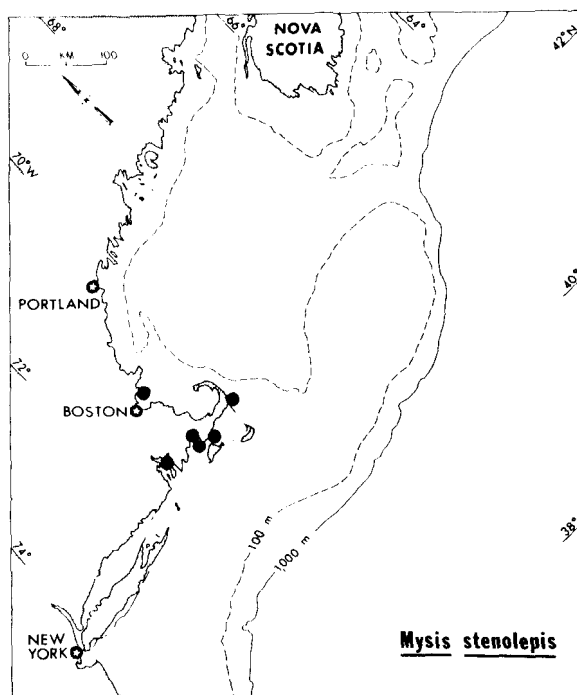


FIGURE 15.—Geographic distribution of *Mysis stenolepis* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

Mass., (Wigley, 1963) the first report of its occurrence outside the north European area. It has also been collected in large numbers from the coast of New Hampshire by Dr. William F. Black (personal communication), and from the Penobscot River (Maine) estuary by Haefner (1969).

The NMFS collection contains 15 specimens from five samples (Figure 16; Burns and Wigley, Table 17), including four specimens from the original seven taken at Barnstable in 1960.

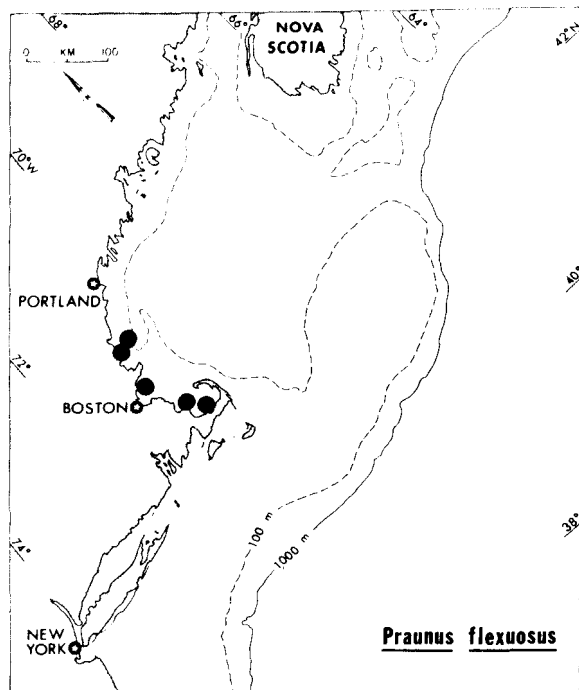


FIGURE 16.—Geographic distribution of *Praunus flexuosus* based on specimens at the NMFS Biological Laboratory, Woods Hole.

[The other three specimens from this collection were sent to Dr. Olive S. Tattersall, who very kindly examined them and verified the identification (Burns and Wigley, Table 17; footnote 2).] The other samples are also from coastal areas north of Cape Cod, Mass. These were collected along shore at Manomet, Mass.; in the harbor at Nahant, Mass. (by Dr. Nathan W. Riser); at Rye Harbor, N.H. (by Mr. John A.

Lindsay); and from a tide pool on Appledore Island, Isle of Shoals, N.H. (by Mr. Stephen Tonjes).

This is a shallowwater species commonly found in tide pools and associated with algae or *Zostera*. All samples in the NMFS collection are from nearshore localities at depths of 5 m or less. The majority of samples were collected by means of a dip net.

Size range of all NMFS specimens is 15.0 to 28.0 mm; males are 15.5 to 19.0 mm and females 16.5 to 28.0 mm. Only three immature specimens, ranging in length from 15.0 to 16.5 mm, are represented in the collection. Sex ratio of the 12 adult specimens is one male to one female.

The spawning season for this species in New England waters, based on the one ovigerous and two larvigerous females in the collection, is at least April through November. It may, however, spawn in this region throughout the year, as it does in Europe. The 25.0-mm female from Barnstable, Mass., held 44 eggs in the brood pouch. The 21.0-mm female from Isle of Shoals, N.H., held 39 stage V larvae in the brood pouch. Although the larvigerous female in the Rye Harbor sample contained 19 larvae, the oostegites were separated and it appeared to be an incomplete clutch.

When this species was discovered in North America in 1960, the question arose whether it was a recent immigrant from Europe, or whether it had inhabited this region for hundreds of years but had been overlooked. After the first capture of only seven specimens most considered it a rare species with only a local distribution in New England. Additional information obtained since 1960, however, indicates it is rather widely distributed between Maine and Cape Cod, Mass., and that it is abundant in the Maine-New Hampshire region. In view of this, and considering the intensive collecting in shallow coastal waters of New England by A. E. Verrill, S. I. Smith, W. Stimpson, and numerous other scientists during the latter half of the nineteenth century, it is our conjecture that *P. flexuosus* is a comparatively new addition to the New England fauna. Possibly it was transported from Europe to a New England port, such as Boston or Portsmouth, N.H., among fouling organisms on the

bottoms of ships during World War II when convoys of merchant ships were making frequent and rather regular transoceanic voyages.

Neomysis americana (S. I. Smith, 1873)

Geographic Distribution

N. americana is the most common mysid inhabiting the northeastern coastal waters of the United States and undoubtedly the most abundant mysid in the western North Atlantic Ocean. It is strictly a North American species, having been reported only from the Gulf of St. Lawrence south to Virginia. It is much more abundant and widely distributed between Virginia and New England than in the northern part of its range.

The NMFS collection originally contained over 2 million specimens of this species—more numerous than any other mysid in the collection, but for purposes of analysis the larger lots were subsampled. Subsamples totaling 8,451 specimens from 168 samples (Figure 17; Burns and Wigley, Table 18) were examined. The geographic distribution of specimens in this collection ranges from off Nova Scotia, near the mouth of the Bay of Fundy, south to Chesapeake Bay.

Most of the specimens are from two regions (Figure 17): (1) eastern Georges Bank to Rhode Island, and (2) from northern New Jersey to Chesapeake Bay. The gap in distribution between these two areas (off Long Island) appears to be more pronounced in offshore waters than inshore. Bigelow and Sears (1939) also encountered a broad hiatus in the occurrence of this species in the offshore waters of eastern Long Island. Yet, inshore in the New York region it has been reported from Great South Bay, Long Island (Smith, 1879) and from Long Island Sound (Verrill, Smith, and Harger, 1873; Smith, 1879; and Richards and Riley, 1967). The only record from offshore Long Island known to us is that reported by Grice and Hart (see footnote 3) which indicated the presence of this species in two plankton samples taken at station 13 located at lat 40°44' N and long 71°41' W (water depth, 64 m). The above rec-

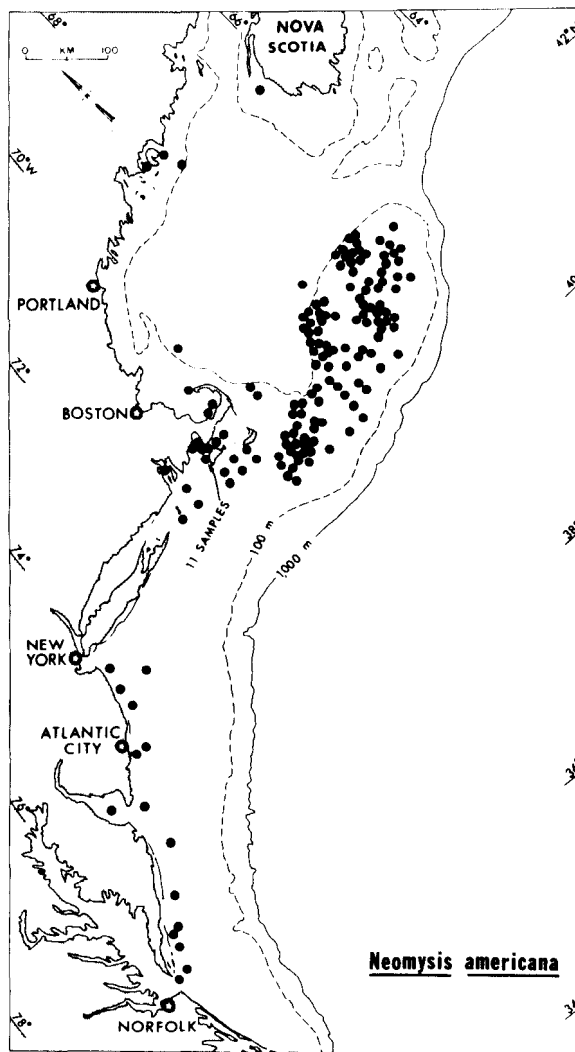


FIGURE 17.—Geographic distribution of *Neomysis americana* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

ords indicate merely a restricted occurrence or low abundance in the offshore New York region, not a complete break in distribution.

Samples from the Georges Bank area during summer and winter revealed a similar distribution of *N. americana* in both seasons. The species was present over most of the bank, with highest concentrations in the central part, the same area where Whiteley (1948) also found them to be most abundant.

Bathymetric Distribution

N. americana is a shallowwater species most commonly reported from the intertidal zone to depths of 60 m. However, it appears to inhabit somewhat deeper water in the Georges Bank region as indicated by the records of occurrence in Figure 17. Whiteley (1948) reported it from a number of plankton samples taken at stations where the water depth was 75 m, but at very few localities where depths were greater than 100 m. Greatest depth reported for this species is 214 m (Wigley, 1964).

Depth range for the samples in the NMFS collection is 1 to 232 m. Frequency distribution for these samples is listed in Table 8. This species is common from the intertidal zone out to 90 m but is most abundant at depths between 30 and 60 m.

TABLE 8.—Bathymetric distribution of *Neomysis americana*, based on the NMFS collection.

Water depth	Samples	Specimens
m	Number	Number
0- 9	5	147
10- 19	14	139
20- 29	20	361
30- 39	19	3,289
40- 49	38	1,998
50- 59	32	1,619
60- 69	13	299
70- 79	12	308
80- 89	4	220
90- 99	2	2
100-109	3	6
150-159	1	3
230-239	1	1
Unclassified	4	59
Total	168	8,451

N. americana undertakes regular vertical migrations between the sea bottom and the upper water layers. Light intensity is the primary controlling element to which the mysids are responding. They move to deeper, darker regions during daytime and upward toward the surface at night (Hurlbut, 1957; Herman, 1963). The NMFS samples provide very little information on this aspect other than to substantiate probable vertical migration in shallow water. At depths of less than 50 m on Georges Bank this species is more common in bottom samples collected during the daytime than at night.

Spawning

Though spawning of coastal populations of *N. americana* takes place throughout the year, it is much more intensive during the warmer months of April through October (Smith, 1879; Fish, 1925; Cowles, 1930; Herman, 1963; Hopkins, 1965). The Georges Bank population was reported by Whiteley (1948) to spawn in the spring. Specimens in the NMFS collection indicate spawning of Georges Bank stocks from March through October and possible spawning in all months of the year. There appear to be two major spawning periods, one in the spring (March through June) and another in the late summer and fall (August through October). Of the ovigerous or largiverous specimens present in samples collected every month from March to October the largest numbers occurred in March through June and August through October. Immature specimens were particularly numerous in August and December. The small number of immature specimens collected in late winter and early spring may indicate occasional small-scale spawning in winter.

Two distinct size groups (summer generation and overwintering generation) of spawning females are discernable; one group spawns in the spring, the other in the fall (Figure 18). Spring spawners have an average length of 11 to 12 mm, and produce a clutch containing about 26 eggs. Fall spawners have an average length of 6 to 8 mm, and their clutch contains only about six eggs. Additional information about these two generations is given below.

Eggs are spherical, 0.38 to 0.42 mm in diameter, in both the summer and overwintering generations.

Size of the larvae varies according to their stage of development. Average lengths in millimeters for the following stages are: stages I and II—0.39, stage III—0.55, stage IV—0.85, stage V—0.96, stage VI—1.15, and stage VII—1.34.

Sex Ratio

The NMFS collection contains 1,574 males and 1,669 females; the ratio is 0.94 male to 1 female.

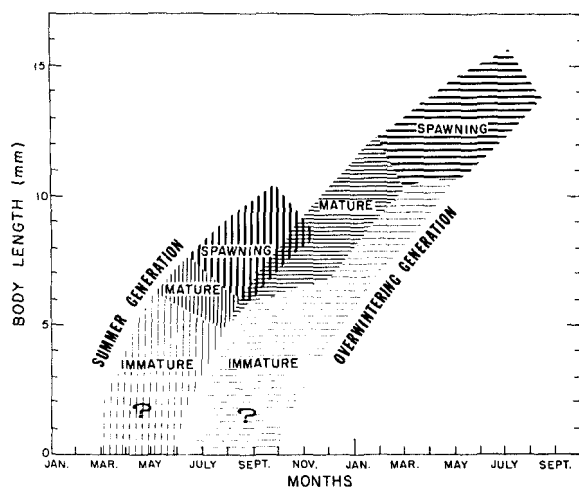


FIGURE 18.—Schematic diagram of the age-size-maturity composition of *Neomysis americana* populations from offshore New England.

Length of Life

The Georges Bank population of *N. americana* appears to consist of two generations: (1) a short-lived summer generation and (2) a long-lived overwintering generation (Table 9, Figure 18). The summer generation stems from eggs that hatch in late winter to late spring. They grow rapidly and mature in late summer and autumn. Length of life of this generation is

TABLE 9.—Range in body length of the (1) summer and (2) overwintering generations of *Neomysis americana*, by sexes and periods.

Period	Range in length			
	Immatures ¹	Males	Females	
			All specimens	Ovigerous and larvigerous
	mm	mm	mm	mm
Summer generation				
May-June	3.0-6.8	5.9-7.4	6.0-7.4	--
July-Aug.	--	5.0-(9.0)	5.1-(9.0)	6.0-8.9
Sept.-Oct.	--	5.7-10.0	6.0-9.6	6.6-8.3
Overwintering generation				
Sept.-Oct.	3.0-7.0	--	--	--
Nov.-Dec.	3.1-7.4	5.5-9.6	5.6-9.6	--
Jan.-Feb.	8.3-10.5	10.6-12.9	11.5-14.7	--
Mar.-Apr.	6.0-10.9	9.3-12.1	9.3-13.3	10.7-12.4
May-June	--	9.5-14.0	9.5-14.0	11.4-14.0
July-Aug.	--	ca.(9)-13.0	ca.(9)-(14.0)	--

¹ Immatures less than 3 to 4 mm length usually passed through the meshes of the sampling and processing equipment.

estimated to be 6 to 10 months. They are the progeny of the overwintering group, the dominant group in the offshore New England area. The overwintering generation originates from eggs that hatch during the summer and autumn, and perhaps even from late spring eggs. They grow at nearly the same rate as the summer generation but do not reach maturity until the following spring. Thus, they are substantially larger than the summer generation. Adults of the overwintering generation are 10 to 15 mm long, compared with 6 to 10 mm lengths for the summer generation adults. Estimated length of life of this overwintering group is 10 to 14 months.

Relation to Bottom Sediments

Although *N. americana* make daily excursions from the sea bottom to upper water levels (see Bathymetric Distribution), a substantial amount of their time is spent on bottom, and they appear to be selective in the type of bottom they inhabit. The bottom type with which they are most commonly associated is sand (Table 10). Kinds of sands they inhabit, in decreasing order of importance are: fine, medium, and coarse. One explanation for the scarcity of *N.*

TABLE 10.—Frequency of occurrence of *Neomysis americana* in various types of bottom sediments, based on the NMFS collection.

Bottom type	Samples	Specimens
	Number	Number
Rock-gravel	5	262
Gravel-sand	10	37
Glacial till	0	0
Shell-sand	4	51
Sand	131	7,987
Silt-sand	7	30
Silt-clay	7	25
Unclassified	4	59
Total	168	8,451

americana in the middle and outer shelf areas south of Rhode Island and New York may be unsuitable sediments. The bottom over much of this area is blanketed with silty sands and sandy silt, whereas on Georges Bank and much

of the nearshore coastal areas where *N. americana* is common, the bottom types are predominantly sands with low silt content (Wigley, 1961; Uchupi, 1963).

Relation to Water Temperature

This mysid is eurythermic and the extremes of temperature in shallow New England waters (0° to over 20° C), in shallow portions of Georges Bank (2° - 18° C), and in the vicinity of the Chesapeake Bay (over 25° C), do not appear to inhibit survival of this species. Reproduction and other life processes, however, are affected by temperature. Also, the sequence, timing, or duration of temperature regimes may be important. For example, in the offshore region south of Rhode Island and Long Island, N.Y., where there is a low abundance of this species, the presence of a layer of cold bottom water (the so-called "cold bubble") may have a pronounced influence in repelling immigrants or retarding reproduction.

Tribe HETEROMYSINI

Heteromysis formosa S. I. Smith, 1873

H. formosa is an amphi-Atlantic species that has been reported in the eastern Atlantic from the northern coast of France, British Isles, and Norway. In the western Atlantic it is known to occur along the eastern and southern coasts of the United States from Maine to the Gulf of Mexico. All except three of the western Atlantic records are from the northeastern sector, between Maine and New Jersey. The three southern records are all from relatively deep-water (48 to 227 m) localities. Specimens from 48 m were collected by Brattegard (1969) off Fort Pierce, Fla. The other two records, reported by Tattersall (1951), are based on collections of the research vessel *Albatross* at a depth of 227 m off the coast of North Carolina (lat $34^{\circ}38'$ N, long $75^{\circ}34'$ W) and in eastern Gulf of Mexico (lat $28^{\circ}36'$ N, long $85^{\circ}34'$ W) at a depth of 203 m. (One additional deepwater sample was collected in the northern region by the research vessel *Fish Hawk* at station 917, located south of Martha's Vineyard, Mass., at lat $40^{\circ}22'$ N, long $70^{\circ}42'$ W at a depth of 81 m.)

The NMFS collection contains 72 specimens from 15 samples (Figure 19; Burns and Wigley, Table 19). The geographic distribution of these

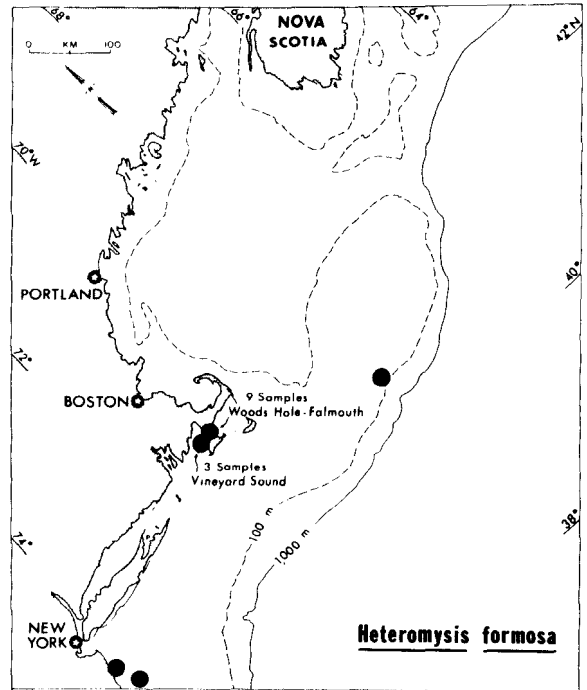


FIGURE 19.—Geographic distribution of *Heteromysis formosa* based on specimens in the collection at the NMFS Biological Laboratory, Woods Hole.

samples extends from southwestern Georges Bank (1 sample) and southern Massachusetts (12 samples) to northern New Jersey (2 samples).

Although the bathymetric range for the NMFS samples is 2 to 84 m, only one sample containing a single specimen was taken at 84 m. All others were collected at depths of 26 m or less. This species customarily inhabits the shallow (1-20 m) inshore areas, such as harbors, bays, and estuaries, where it is much more common than on the outer portion of the continental shelf. The presence of only a single specimen in the NMFS collection from moderately deep water on the outer continental shelf, in contrast to the 71 specimens from inshore locations, illus-

trates the relative scarcity of this species offshore.

Based on NMFS samples, spawning takes place from June to September. Ovigerous or larvigerous females are 5.0 to 8.0 mm long and the number of young per brood is 13 to 15. The average diameter of eggs is 0.4 mm; the length of stage VI larvae is 1.0 mm and of stage VII larvae is 1.7 mm.

The NMFS collection contains 27 males and 31 females, a ratio of 0.9 male to 1 female.

Immature specimens within the size range of 3.4 to 4.5 mm are present in samples from October through January. Body lengths of adults range from 4.7 to 8.9 mm.

This species was collected from a variety of different bottom types (gravel, sand, coarse sand, glacial till, and silty sand). Apparently it has no special affinity for any one kind of sediment, but appears to be more commonly associated with coarse-textured sediments. Members of this species congregate in dead shells of bivalves such as *Mercenaria* and *Spisula*.

Sizes of adult specimens from coastal areas are approximately 5 to 9 mm, whereas the offshore specimens reportedly reach lengths of 15 mm. Owing in part to this difference in size, and partly to their deepwater habitat, Tattersall (1951) considered the possibility that the large offshore specimens collected by the research vessels *Albatross* and *Fish Hawk* might represent a new species closely related to *H. formosa*. He concluded, however, that both groups were similar and only one species was represented.

The deepwater specimen in the NMFS collection is a female only 6.5 mm long. A morphological comparison of this specimen with inshore specimens revealed no major differences that we could detect.

SUMMARY

GENERAL

The principal biological and ecological characteristics for each of the 19 species in the NMFS collection are summarized in abbreviated form in Table 11. This tabulation provides a condensed comparison of one species with an-

other within the NMFS collection and can be used for comparing NMFS information with data from other sources.

TAXONOMIC AFFINITY AND ENDEMISM

The taxonomic affinities of mysids in the NMFS collection are most closely allied with the boreal and subarctic species in the North Atlantic; however, a high degree of endemism is evident.

Nine species having an ampho-Atlantic distribution are: *Eucopia grimaldii*, *Boreomysis tridens*, *Erythrops erythrophthalma*, *Meterythrops robusta*, *Pseudomma affine*, *Amblyops abbreviata*, *Mysis mixta*, *Praunus flexuosus*, and *Heteromysis formosa*. The eight species that are indigenous to the western North Atlantic are: *Bowmaniella portoricensis*, *Hypererythrops caribbaea*, *Pseudomma* sp., *Bathymysis renoculata*, *Mysidopsis bigelowi*, *M. furca*, *Mysis stenolepis*, and *Neomysis americana*. These indigenous species are all inhabitants of warm-temperate to tropical waters. Only one species in the NMFS collection (*Eucopia grimaldii*) is cosmopolitan. Four species (*Eucopia grimaldii*, *Anchialina typica*, *Meterythrops robusta*, and *Amblyops abbreviata*) occur in the Pacific Ocean as well as in the western Atlantic. One species (*Promysis atlantica*) occurs in the South Atlantic and North Atlantic Oceans.

GEOGRAPHIC DISTRIBUTION

The geographic distribution of species represented in the NMFS collection differs in scope from single records (of which there are three) to wide-ranging multiple records. *Mysidopsis bigelowi* has the greatest range, extending from northern Georges Bank southward to northern Florida. *Neomysis americana* has a moderate range, extending from northern Gulf of Maine south to Chesapeake Bay. *Bowmaniella portoricensis* and *Promysis atlantica* have widespread ranges in the southern area, with distributions extending from Virginia to Florida. All remaining species were collected within rather limited geographic areas along the eastern coast of the United States, mostly off New England.

TABLE 11.—Summary of biological and ecological information, by species, pertaining only to mysids in the NMFS collection.

Species	Geographic distribution	Bathymetric range	Bottom type	Body length		Spawning season	Number of eggs per clutch ¹
				Range	Smallest adult		
		m		mm	mm		
<i>Eucopia grimaldii</i>	Slope off southern New England	700	(Silt-clay)	32.0	32.0	--	--
<i>Boreomysis tridens</i>	Slope off southern New England	402	Silt-sand	15.0-26.0	26.0	--	--
<i>Bowmaniella portoricensis</i>	Inner shelf Virginia to Florida	9-56	Sand	3.1-10.0	6.1	Spring and summer	30
<i>Anchialina typica</i>	Inner shelf South Carolina to northern Florida	32-38	Sand	4.5-5.0	4.5	--	--
<i>Erythrotrypis erythrotrypa</i>	Inner and outer shelf and upper slope off New England	18-421	Sand	3.0-9.6	4.3	(May-Oct.) ² Aug. and Sept.	15
<i>Meterythrotrypis robusta</i>	Gulf of Maine	64-150	Gravel-sand	6.6-12.0	8.5	(Possibly spring) ²	--
<i>Hypererythrotrypis caribbaea</i>	Outer shelf off New England	168-179	Sand	5.5-11.0	9.5	Aug.	--
<i>Pseudomma affine</i>	Outer shelf and upper slope off New England	146-329	Silt-sand	4.0-13.1	7.3	July-Dec. ²	11
<i>Pseudomma</i> sp.	Outer shelf off New England	--	Silt-sand	--	--	--	--
<i>Amblyops abbreviata</i>	Gulf of Maine	183-329	Silt-clay	4.7-15.0	10.0	Dec.	29
<i>Bathymysis renoculata</i>	Slope off southern New England	220-366	Silt-clay	4.0-16.2	13.0	(Possibly spring) ²	--
<i>Mysidopsis bigelowi</i>	Inner and outer shelf Georges Bank to Florida	13-179	Sand	2.4-6.6	3.5	(Possibly June-Oct.) ²	--
<i>Mysidopsis furca</i>	Inner shelf off South Carolina	22	Sand	4.2	4.2	--	--
<i>Promysis atlantica</i>	Inner shelf Virginia to Florida	8-26	Sand	4.5-5.0	4.5	--	--
<i>Mysis mixta</i>	Inner shelf off New England	29-159	Various	5.0-25.0	19.0	(Possibly winter or early spring) ²	--
<i>Mysis stenolepis</i>	Shores of southern Massachusetts and Rhode Island	1	Sand and <i>Zostera</i>	13.0-26.0	20.0	Feb. and Mar.	188
<i>Praunus flexuosus</i>	Shores of New Hampshire and eastern Massachusetts	1	Various	15.5-28.0	15.5	Apr.-Nov.	44
<i>Neomysis americana</i>	Inner and outer shelf off New England; inner shelf New Jersey to Virginia	1-232	Sand	3.0-14.7	5.5	Mar.-Oct. (possibly also in winter)	96 426
<i>Heteromysis formosa</i>	Inner and outer shelf Massachusetts to New Jersey	2-84	Various	3.4-8.9	4.6	June-Sept.	15

¹ A large proportion of ovigerous females had an incomplete clutch. The values given here refer only to those with a full complement of eggs.

² Deduced from the presence of immature specimens at a somewhat later season.

³ Clutch size of the summer generation.

⁴ Clutch size of the overwintering generation.

The presence of 15 species in the New England region (Table 12), compared with only 3 species in the Middle Atlantic and 5 species in the Southern area, is due, in part, to more intensive sampling in the New England waters. However, the

TABLE 12.—Geographic classification of species, based on the NMFS collection.

New England (Nova Scotia south to Hudson Canyon)	Middle Atlantic (Hudson Canyon south to northern Virginia)	Southern (Northern Virginia south to Florida)
<i>Eucopia grimaldii</i>		<i>Bowmaniella portoricensis</i>
<i>Boreomysis tridens</i>		<i>Anchialina typica</i>
<i>Erythrotrypis erythrotrypa</i>		
<i>Meterythrotrypis robusta</i>		
<i>Hypererythrotrypis caribbaea</i>		
<i>Pseudomma affine</i>		
<i>Pseudomma</i> sp.		
<i>Amblyops abbreviata</i>		
<i>Bathymysis renoculata</i>		
<i>Mysidopsis bigelowi</i>	<i>Mysidopsis bigelowi</i>	<i>Mysidopsis bigelowi</i>
<i>Mysis mixta</i>		<i>Mysidopsis furca</i>
<i>Mysis stenolepis</i>		<i>Promysis atlantica</i>
<i>Praunus flexuosus</i>		
<i>Neomysis americana</i>	<i>Neomysis americana</i>	
<i>Heteromysis formosa</i>	<i>Heteromysis formosa</i>	

recovery of five species in samples from the southeastern coast of the United States where the sampling was sparse, indicates a relatively diverse mysid fauna inhabits that region. Thorough sampling will undoubtedly disclose a number of additional species (new species plus new records for presently recognized species) in all sections of the coast, though the Middle Atlantic region can be expected to contain the fewest species of mysids.

BATHYMETRIC DISTRIBUTION

The overall bathymetric range at which NMFS mysids were collected is from 1 to 700 m (Table 11). In general all depth zones are rather evenly represented without a preponderance in any one zone. In Table 13 the species are listed under five categories based on the water depths from which they were most frequently caught. Two species were found only in the intertidal zone. Five species are typically

TABLE 13.—Bathymetric classification of species, based on the NMFS collection.

1. Shore Species (occur in the intertidal zone, minimum and maximum depth 0 and 1 m):
<i>Mysis stenolepis</i>
<i>Praunus flexuosus</i>
2. Shallow Shelf Species (occur predominantly at depths less than 50 m, minimum and maximum depth 2 and 84 m):
<i>Bowmaniella portoricensis</i>
<i>Anchialina typica</i>
<i>Mysidopsis furca</i>
<i>Promysis atlantica</i>
<i>Heteromysis formosa</i>
3. Eurybathic Shelf Species (occur over a broad range of depth on the continental shelf, minimum and maximum depth 1 and 421 m):
<i>Erythrops erythrophthalma</i>
<i>Meterythrops robusta</i>
<i>Mysidopsis bigelowi</i>
<i>Mysis mixta</i>
<i>Neomysis americana</i>
<i>Pseudomma</i> sp.
4. Deep Shelf and Upper Slope Species (occur on the continental slope and outer shelf, minimum and maximum depth 98 and 329 m):
<i>Hypererythrops caribbaea</i>
<i>Pseudomma affine</i>
<i>Amblyops abbreviata</i>
5. Slope Species (occur predominantly on the continental slope, minimum and maximum depth 220 and 700 m):
<i>Eucopia grimaldii</i>
<i>Boreomysis tridens</i>
<i>Bathymysis renoculata</i>

Shallow Shelf (less than 50 m) inhabitants. *Heteromysis formosa* is included in this category even though one specimen was taken at a depth of 84 m. This is the only New England species in this bathymetric category; all other Shallow Shelf species are warm-water forms collected in the southern region. Six species are listed under the heading "Eurybathic Shelf Species." They were each taken over a broad depth range (for example, *Neomysis americana*, 1-232 m) on the continental shelf and occasionally on the upper continental slope. Three species that live along the outer margin of the continental shelf are listed under the category "Deep Shelf and Upper Slope Species." Depth range for these species is 98 to 329 m. Three species were taken at depths beyond the outer margin of the continental shelf, from 220 to 700 m. They are listed under the category "Slope Species."

SPAWNING

Information pertaining to the spawning seasons of 13 mysid species in the NMFS collection is summarized in Table 11. Direct information based on the capture of ovigerous or larvigerous

females is the most convincing evidence; this was obtained for eight species. Additionally, indirect evidence from catch records of immature specimens provides clues to possible spawning seasons of seven species, including four species for which direct evidence is lacking.

Spawning of most species for which information is available takes place during the warmer months—May through October. Species that spawn in this season are: *Bowmaniella portoricensis*, *Erythrops erythrophthalma*, *Hypererythrops caribbaea*, *Pseudomma affine*, *Amblyops abbreviata*, *Praunus flexuosus*, *Neomysis americana*, *Heteromysis formosa*, and possibly *Bathymysis renoculata* and *Mysidopsis bigelowi*. One species, *Neomysis americana*, probably spawns in all seasons of the year with maximum production in spring. *Amblyops abbreviata* and *Pseudomma affine* spawn in winter and summer; *Meterythrops robusta*, *Mysis mixta*, and *M. stenolepis* probably spawn in winter or early spring.

The number of eggs or larvae per clutch was counted for eight species. Although the average number per clutch for different species ranges from 6 to 188, these extremes are rare. For most species the average brood contains between 11 and 30; exceptionally small clutches (6 eggs) were produced only by the summer generation of *Neomysis americana*. Unusually large clutches (average of 188 eggs) were typical for one species, *Mysis stenolepis*. A moderately large number of eggs (average of 44) was produced by *Praunus flexuosus*. Both of the latter species are relatively large inshore inhabitants. Small species commonly brood as many eggs as moderately large species; within a species, however, the smaller specimens have fewer eggs than large specimens. The diameter of eggs of ovigerous mysids in the collection was surprisingly uniform. Both large and small species produced eggs that were approximately 0.4 mm in diameter.

BODY SIZE

The smallest and largest specimens (excluding larvae) in the NMFS collection are 2.4 and 32.0 mm in body length. Body lengths were measured for 18 of the 19 species represented

in the collection. (Specimens of *Pseudomma* sp. have not yet been measured.) They have been classified as small, medium, or large. Two criteria were used for determining the appropriate size category: (1) the maximum length of specimens of each species represented in the collection and (2) the length of the smallest adult of each species.

Small species are those with a maximum length of 6.6 mm or less and with the smallest adult 4.5 mm or less. There are four species in this category: *Anchialina typica*, *Mysidopsis bigelowi*, *M. furca*, and *Promysis atlantica*. *Mysidopsis bigelowi* is the smallest species encountered; it matures at a body length of 3.5 mm.

Medium size species are those having a maximum length between 8.9 and 16.2 mm and with the smallest adult 4.6 to 13.0 mm long. There are nine species in this category: *Bowmaniella portoricensis*, *Erythrops erythrophthalma*, *Meterythrops robusta*, *Hypererythrops caribbaea*, *Pseudomma affine*, *Amblyops abbreviata*, *Bathymysis renoculata*, *Neomysis americana*, and *Heteromysis formosa*.

Large species are those with a maximum length of 25.0 mm or more and with the smallest adult more than 15.0 mm long. There are five species in this category: *Eucopia grimaldii*, *Boreomysis tridens*, *Mysis mixta*, *M. stenolepis*, and *Praunus flexuosus*.

RELATION TO BOTTOM SEDIMENTS

A large majority of mysid species in the NMFS collection live on bottom sediments composed of sand or silty sand. They were least abundant and seldom encountered in gravel and rocky areas. (*Eucopia grimaldii* is excluded from this discussion of mysids in relation to bottom sediments, because it is a bathypelagic species.) Eleven of the 18 benthic species were most commonly associated with sand and silty sand. The sand-dwelling species are: *Bowmaniella portoricensis*, *Anchialina typica*, *Erythrops erythrophthalma*, *Hypererythrops caribbaea*, *Mysidopsis bigelowi*, *M. furca*, *Promysis atlantica*, and *Neomysis americana*. The two most common species are both included with the sand-dwelling inhabitants, but there are signifi-

cant differences in the habitats they occupy. *Neomysis americana* are occasionally taken on silty sand bottoms, but typically inhabit sand sediments that are silt free or contain very little silt. Conversely, *Erythrops erythrophthalma* have their center of abundance in areas of sand sediments that contain small to moderate quantities of silt. However, the silt content of the sands they occupy is usually insufficient to classify them as silty sands according to the standard classification established by Shepard (1954). Silty sand inhabitants are: *Boreomysis tridens*, *Pseudomma affine*, and *Pseudomma* sp. The only species that is frequently associated with gravels and other coarse substrates is *Meterythrops robusta*.

Species associated with fine-textured sediments or with various types of bottom materials were usually less abundant and present at fewer localities than the species listed above. Species that were associated with silt-clays are: *Amblyops abbreviata* and *Bathymysis renoculata*. Both species are deepwater inhabitants. Their overall depth range is 183 to 366 m. Fine-grained sediments blanket a large portion of the sea floor at these depths. Species that were found occupying a wide variety of different kinds of bottom sediment types are: *Mysis mixta*, *Praunus flexuosus*, and *Heteromysis formosa*. These are shallowwater species and the most common bottom types they inhabited were: sand, gravel, silt-clay, glacial till, algae, and eelgrass (*Zostera*).

CO-OCCURRING SPECIES

The catch records reveal a high incidence of co-occurrence of the Atlantic coast mysids. Listed in Table 14 are 15 species, 79% of the total number of species collected, taken in the same sample with one or more other species of mysids. The presence of different species of mysids in dredges, trawls, ring nets, and similar sampling instruments that are towed along the ocean bottom for relatively long distances (hundred meters to several kilometers) reveals a reasonably close spatial occurrence. Unfortunately, the spatial separation between specimens of the different species in such samples prior to

collection are unknown. It was especially interesting to find two species in the same grab sample (Campbell sampler or Smith-McIntyre sampler), for example, *Bowmaniella portoricensis* with *Anchialina typica* or *Mysidopsis furca*. This is good evidence that within an area of 0.48 m² of sea bottom *B. portoricensis* lives with *A. typica* or *M. furca*. Also, *Neomysis americana* and *Mysidopsis bigelowi* were caught in the same grab (Smith-McIntyre sampler) samples, but in this case both species were taken from an area of bottom only 0.1 m². These examples, of course, do not mean that these species are competitors. They are strong indicators, however, of close habitation and possible competition for space or other living requirements.

TABLE 14.—A list of co-occurring species. Species in column B were present in one or more samples with the corresponding species listed in column A.

A	B
<i>Bowmaniella portoricensis</i>	<i>Anchialina typica</i> <i>Mysidopsis furca</i>
<i>Anchialina typica</i>	<i>Bowmaniella portoricensis</i>
<i>Erythrotrichops erythrophthalma</i>	<i>Hypererythrotrichops caribbaea</i> <i>Pseudomma affine</i> <i>Pseudomma</i> sp. <i>Mysidopsis bigelowi</i> <i>Mysis mixta</i> <i>Neomysis americana</i> <i>Heteromysis formosa</i>
<i>Pseudomma affine</i>	<i>Erythrotrichops erythrophthalma</i> <i>Hypererythrotrichops caribbaea</i> <i>Amblyops abbreviata</i>
<i>Pseudomma</i> sp.	<i>Erythrotrichops erythrophthalma</i>
<i>Amblyops abbreviata</i>	<i>Pseudomma affine</i>
<i>Mysidopsis bigelowi</i>	<i>Erythrotrichops erythrophthalma</i> <i>Hypererythrotrichops caribbaea</i> <i>Neomysis americana</i>
<i>Meterythrotrichops robusta</i>	<i>Mysis mixta</i>
<i>Hypererythrotrichops caribbaea</i>	<i>Erythrotrichops erythrophthalma</i> <i>Pseudomma affine</i>
<i>Mysidopsis furca</i>	<i>Bowmaniella portoricensis</i>
<i>Mysis mixta</i>	<i>Erythrotrichops erythrophthalma</i> <i>Meterythrotrichops robusta</i> <i>Neomysis americana</i>
<i>Mysis stenolepis</i>	<i>Praunus flexuosus</i>
<i>Praunus flexuosus</i>	<i>Mysis stenolepis</i>
<i>Neomysis americana</i>	<i>Erythrotrichops erythrophthalma</i> <i>Hypererythrotrichops caribbaea</i> <i>Mysidopsis bigelowi</i> <i>Mysis mixta</i>
<i>Heteromysis formosa</i>	<i>Erythrotrichops erythrophthalma</i>

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